EDITORIAL

ATTENTION is directed to closure on page 305 of Mr. C. E. Grunsky's article on 'Determination of the Maximum Storm-Water Flow' which appeared in the November issue. This should be added to the former article in order to make the discussion complete.

RATE increases of 5 per cent for Eastern railroads have been granted by the Interstate Commerce Commission, thus adding about $30,000,000 gross to their annual revenue. While this is not quite as much as the roads asked for, nevertheless we have no doubt that it will be thankfully received, and especially so on 'Change as an indication that the government attitude toward the companies is not one of confiscation or destruction.

OF the many engineering activities that will take place in San Francisco during the Exposition year, one of the greatest is that centring about the petroleum industry. Mr. Irving C. Allen, petroleum chemist for the United States Bureau of Mines, has contributed an article appearing in this issue descriptive of the scope of the petroleum exhibit. This exhibit will, without doubt, be productive of great beneficial results to all those interested in the industry, especially with respect to the dissemination of knowledge of petroleum production methods and refining practice. The World's Petroleum Congress especially will signalize the most notable gathering of petroleum technologists that has ever taken place, and will be a great step toward the collection and correlation of data gleaned from the world's oilfields. Much experimental work will be carried on during the course of the Exposition, and for the benefit of our readers arrangement has been made for the publication in each issue, whenever possible, of complete digests of the progress made and the results achieved. This matter will be prepared under the personal supervision of Mr. Allen, who is in charge of the exhibit, and will be an important addition to existing literature dealing with petroleum technology.

ANNOUNCEMENT has been made of a national foreign trade convention to be held at St. Louis January 21. Some three thousand commercial and industrial organizations have been invited to send delegates, and it appears as if rational steps were about to be taken toward getting down to business with reference to foreign trade opportunities. It is very difficult to obtain definite results through large gatherings. Sectional differences are bound to arise, and the time allotted to the sessions is seldom sufficient in which to perfect anything like an efficient organization. Nevertheless, if the fundamentals can be elucidated and impressed sufficiently upon the minds of those present, much good will result, leaving the details to be determined by each community according to its individual conditions.

THE California State Mining Bureau has been investigating the question of legislative oil-protective measures in real earnest. After a number of conferences with representative organizations of oil producers, a rough draft of a bill to be submitted at the coming session of the state legislature has been made and is now in the hands of the Legislative Counsel Bureau. In brief, the bill provides for the formation of districts when desired by owners or operators. A special tax is to be levied on the land and personal property used in producing oil. The annual tax shall not exceed $25,000 in one district. All taxpayers will select by ballot seven trustees who are to act as a court or arbitration board for the purpose of investigating conditions of wells or property. The trustees are to appoint a geologist or engineer and such other employees as may be required. Witnesses may be summoned by subpoena. If owners do not do work ordered by the trustees, it is to be done by the trustees and the cost becomes a lien upon the property. An annual report is to be made by the geologist and trustees to the State Mining Bureau showing conditions of the field. As soon as the draft of the bill has been completed by the legislative counsel, it will be made public and criticism invited. Operators will do well to lend their hearty support to this movement, as it appears to offer the first definite program for the solution of the water problem since the failure of the Sutherland bill.

Materials for Building Construction

The destruction by fire of the Edison plant at Orange, New Jersey, early in December, again directs attention to present-day methods of building construction. In press dispatches Mr. Edison is quoted as saying: "The big lesson of this fire has been the value of concrete construction. My buildings are gutted, but there they stand ready for refitting." These conclusions are interesting, but hardly novel, especially to residents of the San Francisco district, who, on April 18, 1906, had a $400,000,000 lesson on this subject. Unfortunately, many lessons are required before a complete mastery of a subject is attained, and the effect of even so severe a lesson as the San Francisco fire is

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soon forgotten in the stress of every-day life, and comparative immunity from fire loss for eight years seems to have dulled perception in many quarters.

In building construction there is no such thing as a 'fireproof' structure. The value of building materials is determined by their degree of 'fire resisting' quality. All building materials resist to a certain extent destruction by fire, and it has been conclusively determined in the greatest conflagration known to civilized man what material offers the maximum resistance.

After the San Francisco fire, many and voluminous examinations and reports were made by all sorts and conditions of experts, many in the employ of insurance companies and various commercial interests. Apart from the conclusions of men whose opinions have at times been discounted on the ground that they had 'an axe to grind,' we have often wondered how many structural and designing engineers have on their files a pamphlet known as Geological Survey *Bulletin* No. 324 on the San Francisco earthquake and fire of April 18, 1906, and their effects on structures and materials.

It will be remembered, perhaps, that immediately after the fire, the United States Geological Survey decided to arrange for a thorough investigation of its effect on buildings and materials of construction. Work was inaugurated by Mr. Richard L. Humphrey of the Survey and Captain John Stephen Sewell of the Corps of Engineers, United States Army. Mr. Frank Soulé, then dean of the college of civil engineering, University of California, and Mr. G. K. Gilbert, of the Survey, were also asked to join in the work, and the bulletin to which reference is made above presents the results of their investigations and conclusions.

It is unnecessary to make an extended digest of this bulletin now. Nevertheless, some of the conclusions arrived at by the investigators, in the light of those of Mr. Edison, may well bear repetition.

1. "Exterior openings should be protected by the use of metal frames or metal-covered frames with wire glass, or exterior iron shutters or interior metal-covered shutters, or both exterior and interior shutters."

2. "The structural members, especially the columns, should be better protected, preferably with solid concrete; they may be filled with brick and covered with terra cotta or with a double layer of cement-plastered metal lath, with an air space between."

3. "There should be a better type of partition, the present plastered metal lath or hollow terra cotta tile being inadequate. Reinforced concrete partitions are much more efficient."

4. "All combustible trim should be eliminated. The fire loss from this item is high, and it should be so designed as to be replaced readily and cheaply."

5. "Attic floors and roofs should be designed to resist fire. In many buildings the roof members were not fire-proofed, and their failure caused great damage."

6. "Buildings should be so arranged that the fire can be confined to a single room."

It must be remembered that at the time of the San Francisco fire reinforced concrete buildings were a comparatively recent innovation. The only building of pure reinforced concrete in San Francisco was a warehouse under construction for the Bekins Van & Storage Company at the corner of Thirteenth and Mission streets. Two of the six floors were erected, the walls being made of brick laid in lime mortar and the floors and columns of reinforced concrete. The walls were badly cracked by the earthquake, but the reinforced concrete was not injured. Considerable furniture stored in the building was burned, and the heat slightly blistered the under surface of the concrete floor, which was still green at the time of the disaster. In this connection, it should be remembered that the maximum temperature, lasting but a few moments in each locality was probably 2000 or 2200°F., while the average temperature did not exceed 1500° Fahrenheit.

The early collapse of steel structures due to failure of fire-proofing other than concrete was of common occurrence, and the Geological Survey report is replete with striking instances of the great fire resistivity of portland cement, one instance being that of a cast iron column filled with concrete, in which the cast iron failed, leaving the concrete, which supported the load.

The result of the conditions shown by the San Francisco fire was an immediate boom in concrete construction. San Francisco was the Mecca for all sorts and conditions of contractors, few of whom knew anything about concrete construction, but all were willing to try. And try they did, and some wretched work resulted, due principally to the almost total absence of building regulations at a time when all were eager to expedite re-building. Early mistakes have been rectified as far as possible, however, and most architects and engineers appreciate the fact that such poor work as has been done was due more to ignorance than to the wrong choice of material. It is the owners who are most in need of education, and a realization that temporary buildings are not likely to produce permanent incomes.

A striking example of 'penny wise and pound foolish' is shown by the destruction of the contents of the buildings at the Edison plant. Wooden window sashes, plain glass and wooden doors, and inadequate reinforcement in some of the concrete columns produced the obvious result and the usual comments with reference to a 'fire-proof' building, the contents of which were destroyed by fire. Why owners will persist in following such a course is a mystery. The difference in cost between wooden and steel window sashes cannot be enough of an item to justify this questionable economy, and the same is true of plain glass as compared to wire glass. Cinder concrete seems to have been a failure, while sand concrete stood the test with flying colors. The absence of lateral reinforcement in some of the columns resulted in their shearing diagonally, due to the expansion of the vertical rods. The puzzle in this case is, why should the buildings have been so equipped while knowledge of the folly of such a course has been common ever since the San Francisco fire.

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REVIEW OF THE MONTH

HAPPY NEW YEAR, and why not? For more than half a century there has been no season when the usual greeting customary at this time of the year has had a deeper meaning for the American people. The tragedy now being enacted in Europe seems far from conclusion, while those who slaughter in the name of the Creator seem blinded to the hideous anachronism afforded by their assumption that the Apostle of "Peace on earth, good will toward men," is an ally of carnage and destruction. Retrospection, as far as the late, unlamented 1914 is concerned, seems inadvisable. Rather let us turn to 1915 with confidence and determination to meet whatever may be in store for us with faith in the ultimate destiny of the United States and its people.

THOSE who in 1915 will see America last, have some surprises in store for them. San Francisco will be the Rome to which all roads lead. The Exposition, we are assured, will be ready on time, and so will the hotels, railroads, and others who expect to wax fat by reason of the expected volume of traffic. Nevertheless steps have been taken to prevent gouging our guests as far as possible. Rates for the usual service afforded by hotels have been established at no more than the regular charges, and those who can afford the time and the cost of transportation will find that they may live in San Francisco during the Exposition period as cheaply or more so than they can in their home towns.

WE have always been somewhat inclined to question the material benefits accruing to a people from an international exposition. Of course, it is a gigantic advertising scheme, and as such is theoretically supposed to attract countless thousands who come, and having come, succumb to the wiles of the real estate operator and buy a farm, or perhaps go into business. At any rate, they are supposed to stay. How many of them actually do? We would like to know the experience of Chicago and St. Louis in this regard. Nevertheless, as dyed-in-the-wool Californians, it would take several Expositions to make us want to live all the year round in either Chicago or St. Louis. We in California are long on climate and short on money. The Exposition is supposed to be a sort of clearing house, or first-aid, whereby an exchange of these two requisites to human happiness may be effected. Horace Greeley's advice to young men seems to have been transposed to 'go east to make money, and come west to spend it.'

THE real Exposition, however, is not merely a group of beautiful buildings, or even San Francisco. It is California and the whole Pacific coast. Our natural resources are so great as to have brought about a bad attack of financial indigestion. The cry is always, capital and then more capital. The Panama canal will have a great influence on Pacific Coast products, however. Markets for our wares, previously unavailable on account of transportation cost, are now at our command. Of special import are the prospective developments of our rich farming country. Far-seeing capitalists commenced some years ago the development of many irrigated farm projects apparently secure in the inevitable growth of the agricultural activity of the Pacific Coast states. No foresight could have anticipated the war in Europe, however, and the result of the temporary failure of foreign immigration to materialize has been a bad state of financial collapse of many of the most meritorious enterprises of this character.

LET it not be forgotten that this is a buyers' market. Never has there been a time when so many opportunities existed for the investment of capital in enterprises giving assurance of stability and financial returns. That this condition is appreciated in Europe is shown by the great flow of foreign capital toward California enterprises during the year prior to the war. Many deals of magnitude in process of consummation when war was commenced have been temporarily held in abeyance, but recent news from London would indicate that there is a chance that some of these may be finally completed in spite of the war and financial disturbance in European money centres.

IN the meantime, preparation is the keynote throughout the entire Pacific coast. Not merely the large cities, but the towns and villages also, are placing their best feet foremost in order to get their houses in order for the coming guest. Visitors will find almost universally that the interior districts of California, Oregon, and Washington are conspicuous for their excellent roads, clean and well lighted streets, pure water supply, and better than these, a spirit of civic pride that in itself is the greatest asset a community can have. Western hospitality is proverbial, and fortunate indeed is the motorist who has the time and money to enable him to make the trip over the state highway and Camino Real from San Diego to San Francisco, and thence to the great Pacific northwest during the spring and summer of 1915.

A FEW days ago, a foreign reader commented upon what he regarded as the great amount of work going on in the West. We, who have been complaining about business conditions, are inclined to exclaim at this; nevertheless, it should not be forgotten that what may seem to be dull times to us undoubtedly by contrast ap-

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pears as the acme of prosperity compared to conditions in Europe. It is the embarrassment of riches, especially potential or undeveloped riches. Statisticians have at various times called the attention of the Nation to the great quantities of undeveloped water-power, and to the waste in the oilfields. Until new markets have been developed for power and petroleum, water-power will remain undeveloped and much petroleum will be wasted in production. The causes are in each case economic; power will not be developed until it can be sold, and petroleum will be wasted until it pays to take measures to conserve the production more carefully. We are not arguing in favor of inutilization or waste, but are merely calling attention to the existence of conditions which have brought them both about. What the West needs more than anything else, is more people of the right kind, not in the cities but in the rural districts, men who have a moderate amount of capital and who are not afraid of work. Theorists, invalids, drones or wasters had better stay away. California is not a land of perpetual summer, nor is it a climate that conduces to a life of indolent ease in which the only exertion consists in cutting an occasional orange off the tree or dawdling about the links. This is a country for men, not dilletantes nor sybarites. A moderate capital combined with brain and brawn will stand a better chance to produce independence in the West than in any other section of the United States. For the speculator, who buys merely to re-sell, we have but little use. The builder, the developer who makes two blades of grass grow where one grew before, we welcome with open arms. And this is not mere sentiment. Things have been going rather badly for the speculator these days. Laws, restrictions, public utility commissions, and public sentiment have made it difficult to water a stock issue, unload it on the dear public, and decamp with the proceeds, as was once the order of the day. People have begun to investigate the underlying security for the gaudy stock certificate instead of accepting it as a work of art and letting it go at that.

THE United States has become the market place of the world, while the product most in demand, foodstuffs, comes almost exclusively from the West. Transportation difficulties, especially with regard to transocean traffic, are slowly but surely being overcome. The wealth created by the American farmer finds its way into almost every conceivable channel, and together with the steel industry forms the best index of the prosperity of the nation. The abrupt cessation of the export trade was a paralyzing blow to the steel industry, from which, however, it has shown a gradual but steady recovery. The directors of the United States Steel Corporation have announced that no cut in wages is contemplated at present, and the working period is slowly approaching normal after the low level that obtained during the period immediately following the war. The output of copper is still far below normal, but is showing signs of improvement.

VEXATIOUS questions of the right of the American people as a neutral nation to furnish supplies of various kinds to the belligerents have arisen and will continue to be a matter for diplomatic discussion as long as the war lasts. Nevertheless, given a demand, the supply follows as a matter of course, so while lawyers quibble over a phrase, shipments of all sorts of merchandise will find their way somehow or other to ports in Europe. Stories of large orders for submarines, armored motor trucks, and the like, may fill the columns of the newspapers and stir things up in Washington for a day or so, but we would hazard a guess that the orders, if placed, will be filled by someone, somehow. It is difficult for the lay mind to understand where the line should be drawn between what does or does not constitute a breach of neutrality with reference to furnishing supplies to belligerents. Since war consists primarily of the efforts of one people to destroy another as neatly and expeditiously as possible, is not a roll of antiseptic bandage or a sack of flour just as contraband as an armored motor truck or a submarine? The Hague convention was supposed to establish what was or was not contraband of war, but since then agreements, treaties, and the like, have been filed in the waste basket, and there are but few of us left who still regard an agreement as more than a scrap of paper. Even the American press, especially the weekly and monthly magazines are paying little regard nowadays to the express request of the President to refrain from taking sides in the European controversy. While it is human nature to sympathize with one or the other, at the same time it appears unfortunate that for the sake of the national reputation for fairness, the mighty influence of the press has not done its part in supporting the official attitude of the government.

THE present status of the Mexican situation from our standpoint recalls the old nursery rhyme anent the King of France, who, with ten thousand men, marched up the hill, and then marched down again. Our troops who 'had went' to Vera Cruz 'have came' home again. The Carranzistas, Zapatistas, and all the other varieties of 'istas' are at it as usual, and the period of peace that came with the American occupation has been succeeded by the rattle of the machine gun and a flourishing business for the undertaker. Newspaper diplomats have had a merry time to endeavor to explain the reasons for the military occupancy and subsequent abandonment of Vera Cruz, while the puzzle as to the reasons for the extraordinary course pursued by the administration seem as far from elucidation as ever. Watchful waiting continues to be the order of the day, apparently in the hope that some day absolute exhaustion will effect a cessation of internal strife. Conditions in Europe indicate that the combatants have settled down for a long struggle. It is evident that there will be no desire for American intermediation perhaps for years. Why not make another attempt to bring about peace in Mexico, and this time get something done?

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Mile Rock Tunnel for the San Francisco Sewer System*

Mile Rock tunnel will, when completed, form a part of the sewer system of San Francisco. It extends from Cabrillo street northerly under Sutro Heights to the outfall in the Pacific ocean, and has a horse-shoe section 9 by 11 ft. throughout, as shown in figures 1 to 3. The outfall will be carried to a point where the elevation of the invert will be –13, and on solid foundation, so the exact length of the tunnel is uncertain, but will be approximately 4380 ft. The grade is 0.1606 per 100 ft. throughout.

The tunnel is being driven from both ends; on the north from an adit making an angle of 19°54′ with the centre line and on the south from another adit at right angles to the centre line. The total distance between the points where the adits join the tunnel is 3116 ft. The south heading is in hard blue shale. The north heading passed through blue sandstone for some distance, but is now also in blue shale. The gang in each heading consists of one foreman, four miners, and six shovelers. Two 8-hour shifts are being worked driving the tunnel, and the third shift is devoted to concreting. An average of 10 ft. per day is being made in both headings.

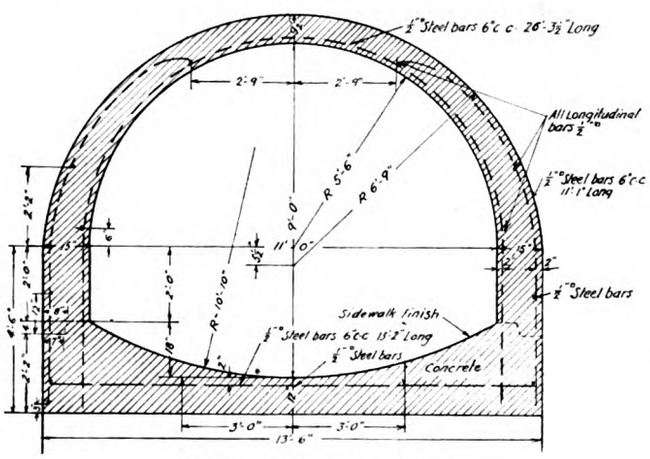
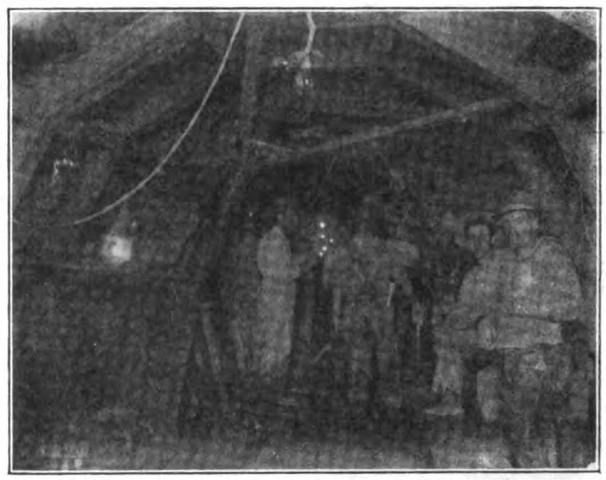


FIG. 1. SECTION IN OPEN-CUT.

The entire section is being taken out at one time. Two 'Little Jap' hand-drills are used in the south heading, and in the north heading two Ingersoll piston-drills mounted on columns. Four holes drilled at the bottom of the drift are shot first. The upper holes are then drilled, the number and arrangement depending on the way the rock has broken out. In the south heading from eight to eleven holes and 25 to 35 lb. of dynamite are needed per 'round.' In the north heading the rock has been harder, and from 17 to 21 holes and 50 to 75 lb. of dynamite were needed; 40% dynamite is used and 6-ft. holes are drilled. The rock breaks out well and there is comparatively little over-breakage.

The rock is hauled away on a narrow-gage track by animal power. A special side-dump car, carrying about ¾ cu. yd. and designed to permit two cars to pass in the tunnel is used. At each end of the tunnel the rock can be wasted near the mouth of the adit. At the south end



INTERIOR OF TUNNEL, SHOWING TIMBERING.

the rock is being used to restore the portion of the great highway that was washed away by the storms of last winter.

A two-post five-segment arch of 8 by 8-in. timbers is used, and the arches are usually spaced 5 ft. centres. Not much lagging is needed, the rock standing up well. Thus far no water has been encountered in the tunnel proper, although in driving the adits a small amount of water of good quality was found, and this water is now being used for concrete mixing and other construction work.

Air for the drills is furnished by a 700-ft. 18-11-17 Ingersoll-Rand two-stage compressor driven by a 150-hp. motor. The compressor is at the south end of the tunnel and supplies the drills in both headings, as well as the special apparatus for mixing and placing the concrete.

One of the most interesting features of the work is the method of mixing, conveying, and placing the concrete, all this work being done by compressed air. A special feature of this method is that its use does not interfere with the simultaneous driving of the tunnel. The cement house and receiving bins for sand and gravel are placed at the mouth of the adit, and the pneumatic mixer is installed directly under the bins. A 1 : 2¼ : 5¼ mixture is used, the aggregate being a special sand and gravel mixture proportioned to give the maximum density.

The mixer is of riveted steel in the form of a double cone and holds a ¼ cu. yd. batch. The top is arranged for gravity loading of cement and aggregate from the bins. A valve connection to the body of the mixer is made to the air pipe from the compressor. At the bottom there is a gate valve and ell connecting with the pipe-line for transporting the concrete. In operating

*Staff article.

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the mixer, measured quantities of cement, aggregate, and water are first admitted to the mixer. The opening at the top is then closed and the air from the compressor turned in, which agitates the batch, producing a thorough mixing of the cement and aggregate in less than a

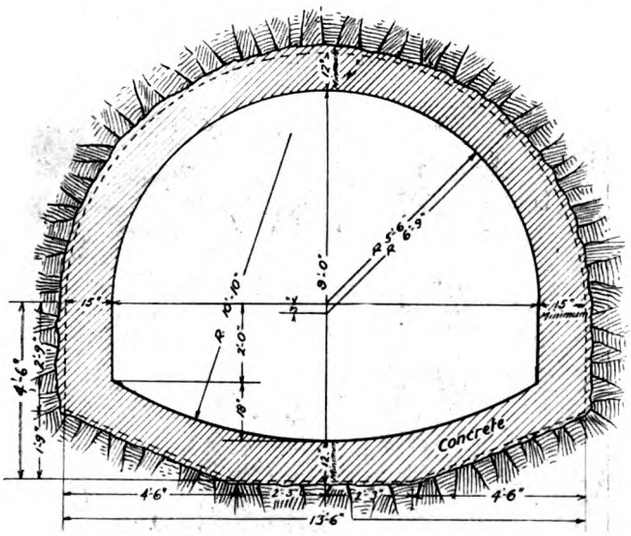


FIG. 2. SECTION IN TUNNEL.

minute. The bottom valve is then opened and the concrete conveyed almost instantly to the forms through a 6-in. pipe. A 6-in. rubber hose is attached to the end of the pipe, enabling the men at the forms to direct the stream of concrete to the proper place. For the entire operation of mixing and placing, only four men are

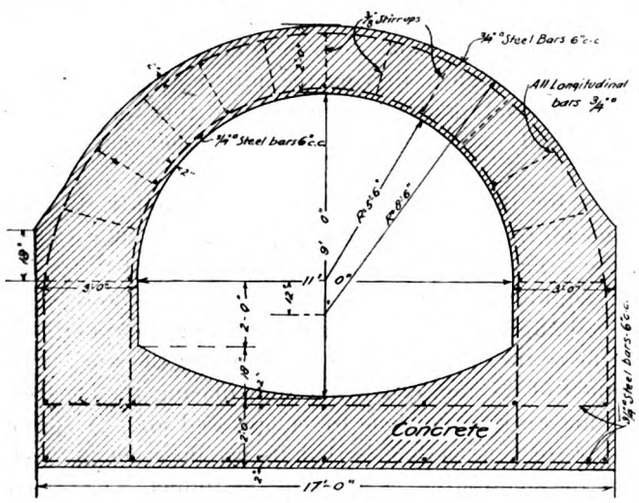


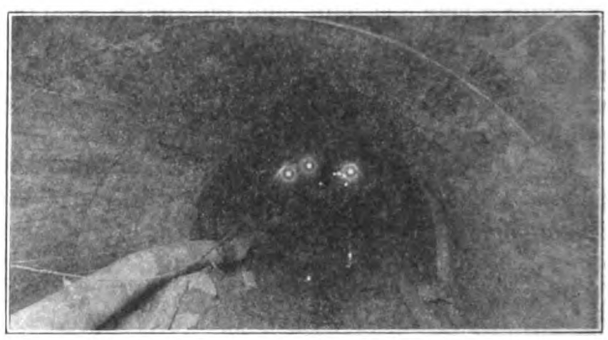
FIG. 3. OUTFALL SECTION.

needed, two to load and operate the mixer, and two at the forms to handle the hose and to signal the men at the mixer by a system of bells.

When the concrete is transported 400 ft., there is no difficulty in placing 15 cu. yd. of concrete per hour, if the compressor is supplying the mixer alone. When the drills are also being supplied from the compressor the output is decreased in proportion to the quantity of compressed air diverted for this purpose.

No experimental data are available regarding the consumption of air in this method, but for an output of 15 cu. yd. per hour, about 1.5 cu. ft. of air per minute per lineal foot of discharge pipe is required. At the prevailing rate for power, this would amount to approximately 15c. per cu. yd. when the concrete is conveyed 400 feet. The maximum distance through which concrete is to be conveyed in this tunnel will probably be about 2000 ft., but it is not likely that the cost of power will increase proportionately.

As conveying the concrete is practically instantaneous, it is in place in the forms before it has even started to set. The finished arch shows that a dense concrete, free from blowholes or uncovered stone, is produced. There can be no doubt of the economy and convenience of this method in tunnel lining and possibly also on certain classes of mass concrete where the yardage is great and the forms not very accessible. On the other hand, it



CONCRETE LINING IN COMPLETED TUNNEL.

would hardly seem applicable to building work; nor, for that matter, to ordinary construction where the yardage is small and where the compressor would have to be added as part of the equipment.

The project was commenced in the spring of 1914, but the original contractor after driving both adits was unable to continue the work. R. C. Storrie & Co., of San Francisco, are completing the work, and commenced in August 1914. The Pacific Concrete Placing Co., of San Francisco, installed the apparatus for mixing and placing the concrete. The tunnel should be completed during the summer of 1915.

Paved streets in Denver, involving a total measurement of 162,266,090 sq. yd., were kept clean for the period from June 1 to December 31, 1913, at a cost of 7c. per square yard, according to the annual report of the Board of Public Works. In addition to the ordinary cleaning and sweeping, the streets in the central paved district, embracing 14,976 city blocks, or 37,440,000 sq. yd. of pavement, were regularly washed during four months of the year. During the summer season the sidewalks used most were washed at a cost of 26c. per block for each washing. An aggregate of 4320 unpaved alleys were cleaned. From them 9370 cu. yd. of rubbish was removed, and hauled to the dump, at an average cost of 59½c. per cubic yard. A ton of rubbish was removed daily at a cost of $7.50.

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A California Concrete Road

By JAMES B. WOODSON*

The San Joaquin valley of California is so situated between the Coast range and the Sierra Nevada mountains that it probably possesses the greatest development possibilities in the state. Through its centre the state highway, already nearly completed, will serve the local through traffic and will be one of the two main routes between northern and southern California.

A portion of this main artery of travel, which has been constructed and under traffic for a longer period than any other section, is a 9.55-mile piece extending northwesterly from the city of Fresno to the banks of the San Joaquin river.

The contract for the construction of this road was let in August 1912 to the Worswick Street Paving Co. of Fresno. The laying of concrete pavement was begun in October 1912, and the concrete work was completed in April 1913. In the work, sections of pavement were thrown open to traffic after the concrete had reached an age of 21 days.

Detail of Pavement

The pavement consists of a 4-in. base of portland cement concrete, 15 ft. wide, covered for the most part with a ½-in. wearing surface of asphaltic oil and broken stone screenings or coarse sand, and has a crown rise of 2¾ in. In addition, 3-ft. dirt shoulders increase the width of traveled roadway to 21 feet.

Grading

Since a firm foundation is one of the first and most important principles of good engineering as applied

PREPARING THE SUBGRADE.

to road construction, the contractor was required to plow or scarify the existing roadway and after pulverizing and cultivating the broken portion, to thoroughly wet and roll to the greatest possible compactness. In this way a subgrade was secured which showed no perceptible movement under a 10-ton road roller.

In order to secure water for wetting the subgrade and concrete, wells were drilled at convenient points and connected with a 2-in. pipe-line. Wherever irrigation canals or old wells were not available, new wells were bored and the water pumped through the

CHARGING THE MIXER.

pipe-line up to a distance of approximately one mile on each side of the pumping station. In this way sufficient water was secured for settling the subgrade, mixing and placing the concrete and keeping it wet for the required period of six days, thus proving that a concrete base for country roads in as warm a section as the San Joaquin valley is practicable and that the handling of the water question and of keeping the concrete moist until thoroughly cured, is possible economically.

The contract for grading was on a mileage basis, though the present policy of the California Highway Commission is to let its contracts for earthwork on the cubic yard basis. The contract price for the grading was $900 per mile, or 10.2c. per square yard of concrete pavement.

Shaping Subgrade and Timber Headers

After the roadway was graded and thoroughly watered and rolled, timber headers of 2 by 4-in. planks, placed on edge and securely nailed inside of supporting stakes, were placed along the outside for pavement forms. These headers conformed to the lines and grades of the edge of the finished pavement, and the subgrade was then shaped to the finished grade of the bottom of the concrete by a wooden template, the bottom of the template conforming to and being approximately 4 in. below the finished crown of the concrete. By 'approximately' is meant that the subgrade

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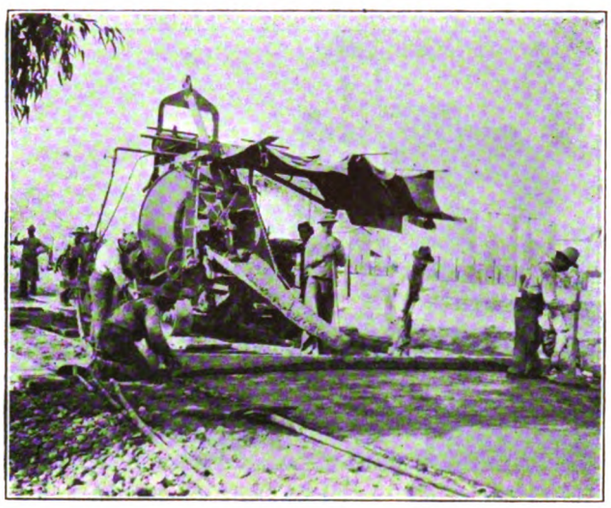
was usually finished a little above the final grade, depending upon the nature of the material forming the foundation, and the final rolling and wetting compacted the dirt to the desired grade. The grade was then kept clean and thoroughly wet immediately in advance of the concrete to insure obtaining a full 4-in. thickness and to prevent any of the water in the concrete from being absorbed by a dry subgrade.

Concrete Base

A 1:2½:5 mixture was used for the concrete, which when properly mixed with clean and well graded



LAYING AND TAMPING CONCRETE.

material has proved to be perfectly satisfactory. This requires on the basis of 45% voids 1.3 bbl. of cement to the cubic yard of concrete.

A Foote ⅔-cu. yd. mixer was used throughout, and the concrete mixed with just enough water to be of a jelly-like consistence, care being taken not to have the mixture so wet that the mortar would flow away from the coarse aggregate, with a resultant 'lean' mixture.

After being placed, the concrete was struck with a template riding on the header boards, and was followed up sufficiently close with wooden tampers and smoothed with a wooden float, there being enough roughness on the finished surface to insure adhesion of the oil wearing surface. It is necessary that the template used in striking off the concrete be accurate in its design and rigid in its construction.

Quality of Materials

The construction of a 4-in. satisfactory pavement permits practically no departure from the specifications. Coarse aggregate for concrete that runs high in percentage of materials passing a 1-in. screen requires an excess of sand to get the finish and therefore makes a weaker mixture of concrete than if the specified quantity of sand is used. Also, too much material in the coarse aggregate passing a ¼-in. screen again reduces the quality of the mixture.

The coarse aggregate on this contract was entirely of clean gravel from the Friant pit. The gravel was well graded from ¼ in. up to 2½ in. The sand was also from the same source, great care being taken to eliminate the clay dirt that was mixed with the sand at the pit.

Frequent tests were made, both in the Division Office and by the resident engineers on the work, to determine the amount of objectionable material in the aggregate. Material containing over 6% by weight of fines passing a 100-mesh screen was considered not satisfactory. Under no circumstances, in the writer's opinion, should 'run of bank' gravel be used for pavements as thin as 4 inches.

Finishing of Concrete

The surface of the concrete was smoothed after the template and tamp had worked and compressed the concrete to the desired shape by means of wooden floats. The floating process is done by one man who, when sufficiently trained, becomes able to keep up with the mixer crew and do all work incidental to cor-

OILING THE ROADBED.

rection of imperfections. A fair degree of skilled labor, however, is required for this class of work and a satisfactory finish requires constant attention from the foreman and inspectors.

Curing of Concrete

Two methods of keeping the concrete wet were employed, one by means of covering the concrete with about 2 in. of loose dirt and saturating the dirt as many times per day or night as may be required to keep a mud coating over the pavement. The other

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method is by means of longitudinal and lateral dikes built about 8 in. high, leaving the bared concrete checked in squares 10 by 15 ft. in area, or smaller. These reservoirs were kept filled with water for a period of about ten days.

Cracks

On account of the expense, artificial expansion joints were not provided for in the specifications.

Some engineers seem to be of the opinion that a properly constructed expansion joint will eliminate the evil of the cracks. It has been demonstrated that the cracks will appear where nature makes them, often within a foot or two of a high-class expansion joint.

The cracks appeared at fairly regular intervals of from 25 to 35 ft. However, no bad results have been occasioned by reason of these cracks, as the first concrete laid was open to traffic seven months before the oil surfacing was applied and on this section there was no perceptible breaking down or disintegration. After two years' use it is difficult to find the cracks.

To test the strength of the 4-in. concrete base under adverse conditions, a trench 2 ft. wide and 4 ft. long was dug on this section under the concrete from the outer edge toward the centre. The rear wheel of a 10-ton Kelly Springfield roller was then run over the unsupported span in several positions without failure, the last position being on the outer edge of the pavement. The wheel was then run onto a 2 by 4 by 8-in. block, thus concentrating the load on a strip 4 in. wide over a span of 2 ft. Again no failure resulted until the block was placed within 6 in. of the outer edge, in which position the wheel of the roller in reality overhung the edge of the pavement. The concrete then crushed under the concentrated load. At the time tested, the concrete was 35 days old.

Concrete was run during 104 days or an average of 484 lin. ft. per day of concrete run. On 24 days out of the 104, over 700 lin. ft. was made, and on six days the daily progress was over 800 lin. ft. The highest run for any 8 hours was 875 lin. ft. with a crew of:

1 foreman	$4.00
1 engineer	3.50
1 water-tender	2.00
1 chute man	2.40
4 chute men, at $2	8.00
11 wheelers and shovelers, at $2	22.00
1 wheeler	2.25
2 men handling planks, at $2	4.00
2 men smoothing concrete, at $2	4.00
1 man tamping	2.00
1 man brooming	2.00
2 men handling cement, at $2	4.00
1 wagon spotter	2.00
1 two-horse wagon and driver (handling boards)	4.50
1 man helping (handling boards)	2.00
1 concrete mixer, fuel, etc	5.00
1 pump and engineer	6.00
33 men, total on concrete work; total cost	$79.65

857 lin. ft. = 158.7 cu. yd. = $0.503 per cu. yd. or 5.6c. per sq. yd. of concrete 4 in. thick.

The total cost to the state of this 9.55 miles of concrete base, including cost of cement, was $49,694.82, making a price of $5203.65 per mile and $0.591 per sq. yd. of pavement.

Bituminous Wearing Surface

Two types of wearing surface were placed on this section. One a mastic mixture consisting of a composition of approximately equal parts of asphaltic cement, 70 to 80 penetration, and powdered lime rock spread to a thickness of ⅜ in., on top of which, after lying, was spread broken stone screenings or coarse sand as needed to absorb the excess of bitumen as it appeared on the surface or as the mixture softened under the heat of the sun. Less than one mile of this type of surfacing was used.

SPREADING SCREENINGS ON COMPLETED ROADWAY.

The other surfacing consisted of an application of approximately ½ gal. per sq. yd. of asphaltic oil spread at from 250 to 300°F., containing 90% of 80 penetration asphalt, on top of which was spread sufficient sand or screenings to absorb the oil. Approximately 0.488 gal. of 90% asphaltic oil per square yard and 250 tons of screenings per mile making 0.03 ton per square yard, making a final thickness of slightly less than ½ inch.

SUMMARY OF COSTS TO STATE

	Total cost.	Per mile.	Per sq. yd. concrete.
Grading	$8,769.31	$918.25	$0.104
Concrete base (including cement)	49,694.82	5,203.65	0.591
Bituminous surfacing (including mastic)	7,779.28	814.58	0.092
Culverts, monuments, guard rail, etc.	389.59	40.79	0.005
	$66,633.00	$6,977.27	$0.792

In conclusion, the writer wishes to state that it is now about two years since the first portion of this road was thrown open to traffic and there has been no failure of any nature observed in the pavement, and no maintenance expense except for some small repairs of the dirt shoulders and for sanding a portion of the road where the oil appeared too freely on the surface.

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Petroleum Exhibit at the Panama-Pacific International Exposition

By IRVING C. ALLEN*

The petroleum industry is one of the greatest and most important in the world. The United States produced in 1913 crude petroleums and natural gases having a total value of approximately $324,847,000. This is 71% of the value of the world's total production during this period. With the present universal uses of machinery, necessitating the use of fuels and lubricants, petroleum products are necessaries.

The desirability, therefore, of having a petroleum exhibit at the Panama-Pacific International Exposition that would adequately exhibit the industry and 'tell the story of oil' is evident.

The United States Bureau of Mines has been studying the chemistry of natural gases and petroleums in the laboratory for about seven years, and methods for the conservation of natural gases and petroleums in the field for about three years.

Realizing the necessity of more practical field studies than had heretofore been possible, not only in the chemistry of oils and gases, but also in the drilling for oil and gas, their transportation and storage, refining, testing, and using, the Bureau wished to develop a petroleum exhibit at the Panama-Pacific International Exposition where all of these studies could be adequately demonstrated.

Neither the money voted by Congress for the use of the United States Bureau of Mines nor that voted by Congress for the use of the Government Board at the Panama-Pacific International Exposition contemplated this exhibit. It was necessary, therefore, to turn to the petroleum industry for help, and the petroleum exhibit has been made possible by direct contributions from the governing boards of the oil producing counties of California, especially Fresno, Kern, Santa Barbara, and Orange; the companies and individuals interested in the petroleum industry; the Commissioner General of California State Exhibits; societies and associations concerned with petroleum studies, and by the departments of the Government studying petroleums for the United States Government or using the products of petroleum.

The organization of this exhibit is largely the work of the United States Bureau of Mines, through which the aid of various companies and individuals has been enlisted.

The petroleum exhibit will show the latest and best in the petroleum industry. It will 'tell the story of oil' in a manner entertaining and instructive to the general public and to the driller, the producer, the scientist, and the financier, who are especially interested in some way in the petroleum industry.

(NOTE.—Because on the date of the issuance of this edition of the Petroleum Exhibit Bulletin the lists of exhibits is not complete, it has been thought advisable not to publish the names of individual exhibitors.)

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Location

The principal part of the petroleum exhibit will be situated in the open, outdoor space belonging to the Department of Mines and Metallurgy, which is east of the Palace of Machinery, and will cover about 52,700 sq. ft. of ground. This space is well chosen for an exhibit, because it is in the centre of the activities between the main exhibit palaces and the amusement zone.

An auxiliary exhibit will be installed in a space of approximately 600 sq. ft. in the Palace of Mines and Metallurgy where a large collection of mined products, *i.e.*, crude petroleums, from the many oilfields of the United States and abroad will be shown.

A second auxiliary exhibit will be installed in a space of approximately 600 sq. ft. in the Palace of Machinery, where a large collection of typical fuels and lubricants, materials used in modern machinery practice, will be shown.

The petroleum exhibit will consist of nine principal divisions, as follows:

1. A pictorial display.
2. A geological display.
3. A statistical exhibit.
4. A library of petroleum literature.
5. A technological exhibit.
6. The display of a large collection of crude and refined products.
7. An exhibit displaying housing and sanitary problems.
8. Lectures.
9. An exhibit displaying fire hazards and methods of preventing and fighting fires.

1. Pictorial Display

The pictorial display will consist of a large collection of photographs of important oilfields, interesting and historical wells, and incidents of importance to the petroleum industry. This will consist of ordinary photographs, transparencies, and motion pictures. A large collection of maps of the important oilfields of the world will be shown.

2. Geological Display

The geological display will consist of relief models and will show:

The geology and developments of the west-side fields of the San Joaquin valley of California on a scale of 3 in. to the mile;

Relief models of the Los Angeles-Orange Counties fields;

Models on a large scale of the typical producing anticlinal fold of the Ventura and other districts;

Models of developed oilfields, drawn to scale, show-

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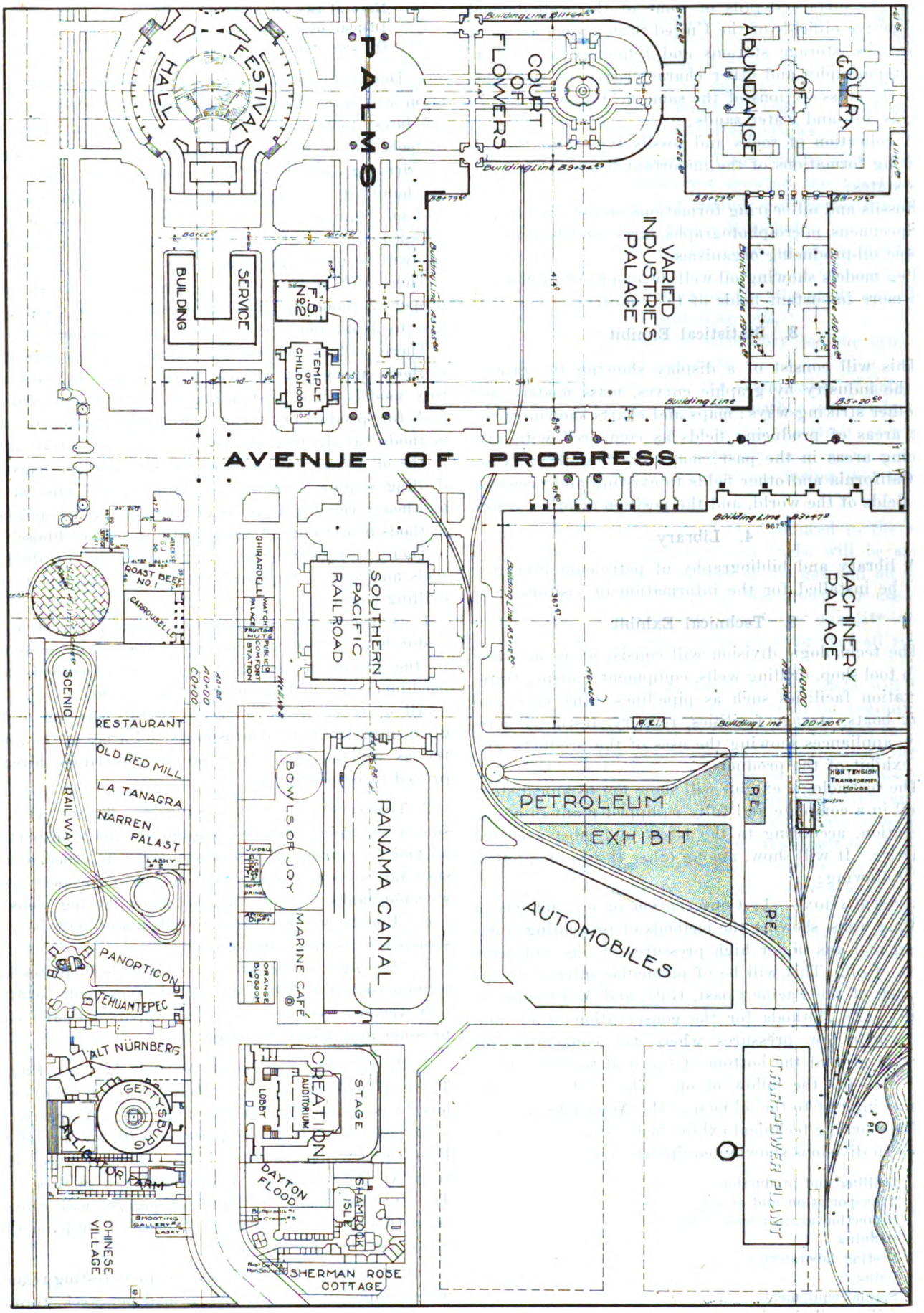

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ing: (*a*) surface details of some of the well defined and active oilfields of the United States, such as wells, pipe-lines, storage stations and refineries, as well as the topography and other characteristics of the field; and (*b*) cross-sections of the same field showing strata of gas, oil, and water sands;

A collection of rocks and fossils typical of the oil-bearing formations of the important fields of the various states;

Fossils and oil-bearing formations and marine life;

Specimens, micro-photographs, large models of microscopic oil-producing organisms;

Peg models showing oil-well development of some of the more important fields of the country.

3. Statistical Exhibit

This will consist of a display showing the growth of the industry by graphic curves, mass models, and in other striking ways; maps and charts showing present areas of producing fields as compared with producing areas in the past; maps showing the relation of California and other fields to existing and prospective fields of the world, and the position of other states.

4. Library

A library and bibliography of petroleum literature will be installed for the information of visitors.

5. Technical Exhibit

The technologic division will consist of an oil camp with tool shop, drilling wells, equipment showing transportation facilities such as pipe-lines, tank cars, and tank boats, storage facilities, refinery, testing laboratory, appliances showing the uses of the products, and an exhibit of the products.

The technologic exhibit will show the technical story of oil in a complete and fully equipped plant in actual operation, according to the latest and most accepted practice. It will show, among other things of interest, the following:

Conservation.—(1) Conservation of oil and gas in drilling wells, showing the methods of preventing waste of oil and gas under high pressures of gas and large flows of oil. This will be of particular interest to the oil men of the Pacific Coast, Gulf, and Mid-Continent fields. (2) Methods for the conservation of oil and gas under low pressures where the congelation of paraffin around the bottom of the well seals the wells and prevents the inflow of oil. This will be of particular interest to the oil men of the Appalachian fields.

The working technical exhibit will consist essentially of seven divisions showing equipment and methods for:

1. Drilling and production.
2. Transportation and storage.
3. Protection against loss by fire.
4. Refining.
5. Testing laboratories.
6. Using.
7. Special equipment:
   - Water-oil electric separators.
   - Natural gas compressors.
   - Display of gas generators.
   - Oil gas producers.

1. Drilling.—Full-sized drilling rigs in actual operation will show standard equipment, complete with all the latest tools and appliances, including a full outfit of tools, cables, tubing, pumps, powers, etc.; equipment for drilling, both rotary and cable systems; equipment for handling of high pressures and large flows of gas and oil; equipment for saving oil and gas under low pressures and small flows. The equipment and methods will be of the latest and most approved types.

There will be shown to the prospective investor the proper methods for developing oil territory and help him to avoid improper methods and mistakes.

There will be presented, demonstrated by practical methods and equipment (and not simply by toys and tiny models), the most approved methods for drilling and for production. This will show equipment and methods for drilling shallow territory, of direct value to the oil prospector; heavier but still portable rigs for drilling shallow territory, of value to the wild-catter; and heavy rigs for deep drilling with the latest and best methods of drilling, of value to the producer himself.

There will be shown a large collection of drilling tools and special appliances of unusual interest to the drilling engineer.

It is proposed to demonstrate to the prospective investor how to test his territory. There will be shown to the producer the latest and newest methods and machinery for drilling and for production.

All of this will be of value to the investor in the great unprospected but prospective oil areas of the country as well as to the producers in territory already proved to be productive.

2. Transportation and Storage.—There will be shown the latest and best equipment for transporting oil and for storing oil in earthen, concrete, wooden, and steel tanks; field storage with models of properly constructed tanks for collecting oil from flowing wells:

a.—For heavy oils proper baffle-plates will be constructed to prevent splashing;

b.—For light oils closed covers with baffle-plates and column coolers will be constructed; these will be fitted with vacuum systems to draw off vapors for later compression and use in blending.

3. Protection of Storage Against Loss by Fire.—There will be studies of methods for the prevention of loss by seepage, evaporation, and fire. A special exhibit will be made in co-operation with several of the Fire Underwriter Boards of the United States, when from April 18 to 24 an 'Insurance Week' will be held. The International Fire Waste Congress will convene from October 7 to 9, and the World's Petroleum Congress from October 25 to 30.

4. Refining.—There will be a complete testing refinery with a capacity of about one carload per week, through which will be actually run typical crudes from the impor-

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tant oilfields of the country, and from which will be obtained all the products possible to be made from the crude. It will be possible to make these products in such quantities that it will be practicable to use them as lubricants or fuels in the machines in the Palace of Machinery. The refinery will consist of three batteries of stills, fifteen stills in all, each still having a capacity of from 140 to 220 gallons. The batteries of stills will be so arranged that they can be run either continuously or intermittently. All of the necessary auxiliary equipment will be installed and used, such as tanks, steam and vacuum stills, agitators, asphaltum plant, and wax plant.

The refinery will be run according to the latest and most approved methods, thus demonstrating the best conservation of heat and the saving of gases and light vapors from the stills by compression and blending. The exhibit will include:

a.—Vacuum system for heavy oils.

b.—Saturated and superheated steam systems.

c.—Systems with inert gases.

d.—Battery of continuous stills.

This battery of stills, running continuously, will give from fifteen to twenty cuts, producing gasoline, which will be shown burning directly in automobiles and stationary engines; and gas oil, which will be shown yielding gas for domestic use by means of an illuminating gas producer. The gas will be shown burning in lamps and cookstoves. The gas oil will also be shown yielding fuel gas by means of a fuel gas producer, and the gas shown driving a gas-engine.

The heavy naphthas will be shown burning directly by the aid of heavy naphtha or kerosene carburetors in an automobile. (This type of carburetor will soon be one of the most important factors in the production of cheap automobile fuel.)

The heavy fuel oils will also be shown driving Diesel engines, both marine and stationary types, and burning in oil burners under boilers for generating steam both for stationary and marine engines. The gas-engine, heavy-oil engine, and steam-engine will be shown driving electric motors which in turn can be used for drilling the well.

Petroleum products of all kinds will be made. From the battery of stills will be made petroleum ethers used for pharmaceutical and chemical purposes, and also for blending with heavy naphthas to make the latter usable in automobiles, also gasolines, kerosenes, paint naphthas, non-viscous lubricants, viscous lubricants, cylinder stocks, vaselines, paraffins, and asphaltums. These products will be shown in actual use. Asphaltum residues will be shown actually used in making streets and pavements, as will also methods of treatment, including washing and purifying.

It is most important that the oil from the important fields of the country pass through these refining, chemical, physical, and engineering tests, that one may be able to state definitely that from the particular crude under examination certain first-class products can be obtained which will be compared in all particulars with similar products of any other field in the country. This information has never been obtained for the public up to this time, and this is an opportunity to obtain accurate information at a minimum cost that will show the true value of all the important crudes.

5. Testing Laboratories.—There will be model, fully equipped testing laboratories showing the latest and most approved methods of testing, and the instruments and apparatus used. These will include:

(1) A works laboratory for checking and controlling the refinery runs.

(2) A photometric laboratory for the study and the development of lamps and lamp oils.

(3) A scientific research laboratory for the critical study of methods and materials.

(4) A gas laboratory for the examination of natural and artificial oil-gases, both illuminating and producer.

(5) An asphaltum laboratory for the study of road oils and asphaltum paving materials.

Actual testing will be carried on during the entire time of the Exposition.

6. Uses.—Some of the products produced in the refinery, such as the lubricants and fuels, will be supplied to the engineers in charge of the gas and oil engines running in the Palace of Machinery for use in their engines. Critical data as to the quantity and quality of these oils will be kept in order that all runs may be considered test runs.

Technical data.—Careful and complete data will be kept of all information about the oil from the beginning of the drilling operations to the end of its uses in its transit through the plant. From the engineering data obtained by the engineers working on the machines in the Palace of Machinery, using the fuels and lubricants, together with the chemical and physical data obtained from the chemical and physical examination of the crudes and their products in the laboratory, combined with the knowledge as to how the products have been prepared or refined in the refinery, and with the knowledge of the history and source of the crudes, it will be practicable to obtain all the information possible in regard to the crude, together with full information regarding all the possible products to be made from it. It will also be practicable to ascertain the adaptability of any particular product for a specified use.

7. Display of Special Equipment.—Special displays will be made of interesting and special equipment:

Water-oil electric separators.—There will be shown a working model of an electric water-oil separator showing methods of continuously separating water from emulsified oil.

Display of natural-gas compressors.—Display of natural-gas compressors will be made. These plants will show the methods of producing gasoline from natural gas:

a.—By compressing and cooling with cold water;

b.—By compressing and absorbing in heavy naphtha;

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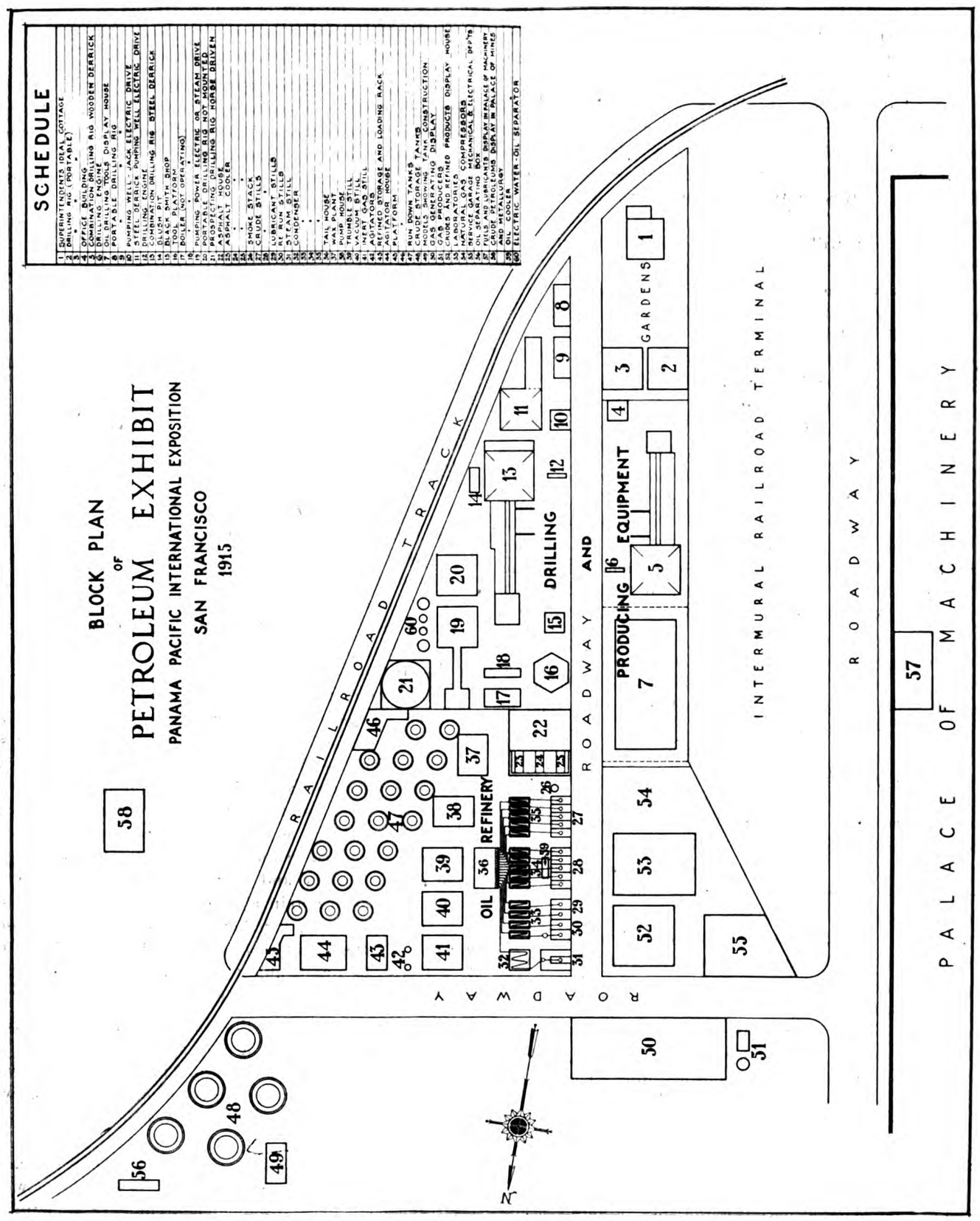

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c.—By compressing and cooling under expansion; and
d.—By condensation by ammonia cooling.

Display of gas generators.—A display of gas generators will be made. There will be shown equipment for generating gas from gasolines, of use in producing light and heat in isolated houses, stations, etc.

Oil-gas producers.—An oil-gas producer will be installed that will generate oil-gas from oil wastes, and this gas will be used to drive certain gas-engines in the Palace of Machinery.

6. Samples

There will be an exhibit of all types of crude petroleums produced in the United States, and some from abroad. There will be a display of samples of practically all refined products from some 250 refineries in the United States, and the crude oils from which these samples have been made will also be shown. The commercial composition, chemical composition, and the physical characteristics of these products will be indicated. These companies are sending 5-gallon samples of each of their products. These will be shown in attractive glass bottles, properly illuminated and labeled with data of interest. The excess of samples will be used for critical scientific examination, which will develop valuable information as to the comparative quality of the oils produced from various districts and of various origins. This will be of great commercial, economic, and scientific importance.

7. Housing and Sanitation

There will be studies of the sanitation of isolated camps. Model cottages will be shown, built with practicable conveniences, with gardens, yards, and all necessary outbuildings. These studies will have for their particular object the welfare of the workers.

8. Lectures

Lectures, illustrated by views and moving pictures, will be given in suitable halls at stated periods by eminent men interested in the petroleum industry. Five-minute addresses, describing the petroleum exhibit in detail, will also be given at suitable intervals.

9. Fire Hazards

The exhibit displaying fire hazards and methods of preventing and fighting fires will be developed in co-operation with the Insurance and Petroleum Congresses mentioned below and with the fire departments of the Exposition and the city of San Francisco.

Congresses

Three congresses of especial interest to petroleum men will be held during the Exposition, as follows:

(1) Insurance Week, April 18 to 24.—On April 24, 'Fire Prevention Day' will be held, for which the following program has been tentatively arranged:

Parade in morning. Floats by Fire Prevention Associations from all over the United States and Canada, manufacturers of all kinds of fire-fighting apparatus and fire-protection apparatus or material.

Prizes for best educational display.

Exercises on Exposition grounds during afternoon and evening.

Competitive exercises by crack teams, ladder drill, leaping into nets, tugs-of-war, etc.

Medals for winners.

Tests of fire-fighting apparatus, supervised by expert engineers. Records to be kept for publication.

Spectacular burning of mining camp in Stadium. Rescue from two and three-story building by firemen.

In evening, spectacular oil tank fire, on land, and barge on water, latter extinguished by fireboat.

Grand carnival in the Zone in evening.

(2) International Fire Waste Congress, October 7 to 9.—From October 7 to 9 the 'International Fire Waste Congress' will be convened, and special studies and displays for preventing fire wastes will be made.

During these Congresses special displays of equipment for fighting oil fires will be demonstrated. This will show the best practice in using high-pressure and low-pressure water and steam, sand, and chemical extinguishers, together with the special equipment used. The precautions to be taken will be demonstrated using burning tanks of oil on North Beach.

(3) The World's Petroleum Congress, October 25 to 30.—Of particular interest in connection with the Petroleum Exhibit will be the World's Petroleum Congress, to be held from October 25 to 30. This week has been reserved by the officials of the Panama-Pacific International Exposition as a period for discussions and conferences on matters of interest to the men of the petroleum industry. To this congress all persons interested in the petroleum industry are invited. The success of the World's Petroleum Congress is assured because a large number of societies and individuals have already expressed themselves as desirous of participating.

It is expected that, among others, the following societies and commissions will participate:

The American Petroleum Society, San Francisco.
The National Petroleum Association, Cleveland.
The Western Petroleum Refiners' Association, Tulsa.
The Independent Petroleum Marketers' Association of the United States, Cleveland.
The Institute of Petroleum Technologists, London.
The International Petroleum Commission, Karlsruhe.
The International Petroleum Institute, Bukharest.
The Gasoline Producers' Association, Parkersburg.
The Independent Oil Producers' Agency of California, Los Angeles.
The Chamber of Mines and Oil, Los Angeles.
The Independent Oil and Gas Producers' Association of Oklahoma, Tulsa.
The Oklahoma Corporation Commission, Oklahoma City.
The Louisiana Conservation Commission, Shreveport.

The Petroleum Committees of the following societies are asked to send representatives:

The American Chemical Society.
The American Society for Testing Materials.
The National Fire Protecting Association.
The Engineers' Society of Western Pennsylvania.
The Natural Gas Association of America.
The American Automobile Association.

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The American Association for Highway Improvement.
The Society of Automobile Engineers.
The American Association of Consulting Engineers.
The American Mine Safety Association.
The American Society of Civil Engineers.
The American Mining Congress.
The Paint Manufacturers Association of the United States.
The National Paint, Oil and Varnish Association.
The American Institute of Mining Engineers.
The American Society of Mechanical Engineers.
The Western Wholesale Oil Jobbers' Association.
The Refined-Oil Jobbers' Association.

Program

Besides the many attractions of the Exposition, the state of California, and the numerous points of interest *en route* to and from the Pacific Coast that will attract the visitor to San Francisco, the program for the World's Petroleum Congress is receiving most careful attention by a large number of men prominent in the petroleum industry.

A large number of technical and scientific papers from America and abroad are assured. The wealth of material for presentation and discussion has made it necessary to divide the program into several divisions, and the following are being tentatively arranged for:

1. Literature.—History, current literature, bibliography.

2. Exploration.—Reconnaissance, geology, prospecting.

3. Development and Production.—Drilling, bailing, and pumping.

4. Transportation, Storage, and Distribution.—Pipe-lines, tank cars, tank wagons and small containers, tank boats, field tankage.

5. Properties and Characteristics.—Physical, chemical, testing methods.

6. Refining.—Heat treatment, electric treatment, chemical treatment, physical treatment, mechanical treatment.

7. Utilization.—Medicinal, light, heat, power, structural and preserving, lubrication.

8. Legal Rules and Regulations.

9. Statistics.

Special provision is being made for assembly and lecture halls.

Excursions

Special excursions to the great petroleum fields of California and Oklahoma are being arranged for.

Social Entertainment

A special program is being prepared.

The American Petroleum Society

To Promote the Science of Petroleum Technology.—The American Petroleum Society has been organized by men who produce, refine, market, and consume petroleum and its products, including bitumen and natural gas. It was organized for the purpose of funding the general knowledge on petroleum at present in possession of the many men interested or engaged in the industry, in order that this knowledge might be co-ordinated and arranged so that it could be made use of by those interested, and also that by systematic and united study and research this knowledge might be increased.

The organization of this society was determined upon at a meeting of the secretaries of some thirty societies and associations, interested in some way in the petroleum industry, held at the United States Bureau of Mines Laboratories at Pittsburgh, Pa., August 1, 1913. The organization was perfected and temporary officers were elected at a meeting at the same place on September 10, 1913.

Because of the prominent part the petroleum industry is taking in the Exposition, it has been thought advisable to make the Petroleum Exhibit the headquarters of the Petroleum Society during the entire time of the Exposition. All communications addressed to The Secretary, American Petroleum Society, Petroleum Exhibit, Panama-Pacific International Exposition, San Francisco, California, will therefore be promptly attended to.

The aggregate attractions of California, the bay district, the Panama-Pacific International Exposition, particularly the displays of the petroleum exhibit and the scientific, technical, and social programs of the World's Petroleum Congress, offer opportunities for entertainment and profit in which everyone, particularly those interested in any way in the petroleum industry, should participate.

Each visitor, whoever he is, or from wherever he comes, will be most welcome, and will be received and entertained in such manner that he will wish to remain.

The Mine

In Block No. 6 of the Palace of Mines and Metallurgy, the United States Bureau of Mines, in co-operation with various mining companies and manufacturers of machinery, powder, and mine safety appliances, has installed a demonstration mine. This, under the floor of the building, is to illustrate various methods of mining practised by the principal metal and coal mines of the country. It gives an excellent idea of the conditions to be found in the mines of the United States. First-aid and rescue work will be a prominent feature of this exhibit.

Vancouver is to have a branch laboratory of the Canadian internal revenue department. The necessity for a branch laboratory on the Pacific coast has been apparent to the Dominion department of chemistry for some time. Vancouver manufactures a great deal of material requiring analysis, and the consuming power of the city is sufficient to justify the establishment of a departmental branch in this port. In the past all samples of goods subject to analysis have been sent to Ottawa for treatment, which has caused much delay, especially to people who import raw materials in bulk and treat them in Vancouver.

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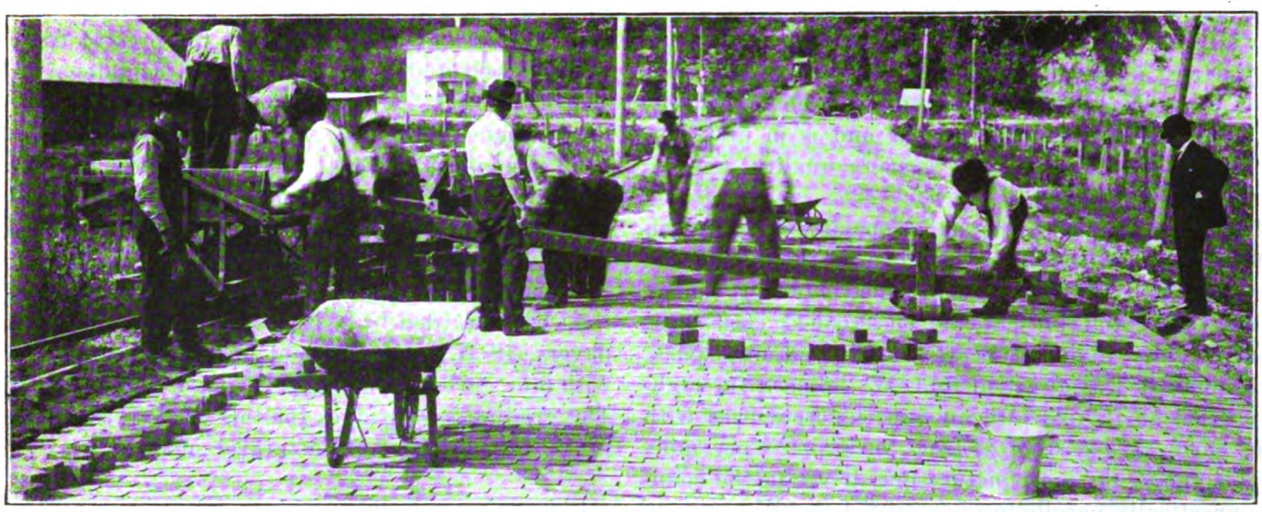


Brick Highway in King County, Washington

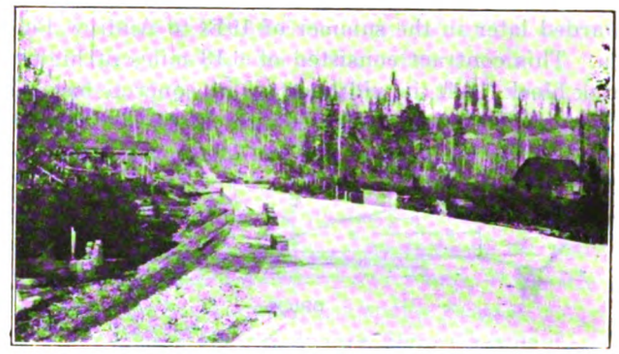
By F. W. ALLEN*

Brick pavements for trunk highways are becoming more in demand every year by the thousands of users in this section of the country. Until the spring of 1912, there was not a brick highway in the state of Washington; brick previous to that period was considered an extravagant waste for a county road. J. R. Morrison, who was county engineer at that time, had the courage to call for bids on 2.75 miles of brick highway to be built under the permanent highway laws of this state. His recommendation was followed by the Board of County Commissioners, and the contract was awarded to T. Ryan at a cost of $59,524. This was the first time in the state that brick was used for a county road. This highway extends from the town of Kent southerly for 2.75 miles, forming a unit of the Pacific highway, constructed under the name of permanent highway 3a. Kent lies about 16 miles south of Seattle.

This road was constructed 16 ft. in width, with No. 2 pavers on a 5-in. concrete base, and 5-in. curb, and was completed in the early spring of 1913, having had two seasons' wear without any marked deterioration to its wearing surface, or appearance of surface cracks. No transverse expansion joints were used in the construction. During the summer this pavement arched to a slight extent. The pressure in some joints was so great that the brick was crushed. This is noticeable only by a very close examination.

This highway is subjected to heavy traffic. The White River valley, where the road is situated, is exceptionally rich, and very thickly populated. It is served by three steam railways, and an interurban from Seattle to Tacoma. Until the past few years practically all the farm products from this district were carried by the interurban, but auto freight has taken the place of the railroad, and cut the cost of hauling in half. While this office has no traffic census on this road, it would be safe to say that the total tonnage for freight equals or may exceed that on some of the main thoroughfares in Seattle. The average auto truck, loaded, will weigh not less than 8 tons, with practically three-fourths of the load on two rear wheels, while some of the trucks run as high as 11 and 12 tons. One distinct advantage in this traffic is that most of it is carried on rubber tires, reducing the injury to the surface materially.

In the spring of 1913, A. P. Denton, the present county engineer, deemed it advisable that the entire



A COMPLETED HIGHWAY.

permanent highway fund should be spent for brick roads. Plans and specifications were drawn up for 12.62 miles of this class of highways, and approved by the State Highway Department. Plans and specifications were also prepared and bids called for warrenite, asphalt, granitoid, and dolarway. The Board was favorable to brick on all three highways.

The first of these roads to be completed was the extension to Permanent Highway 3c, south of Kent to Auburn, a distance of 3.10 miles. This contract was

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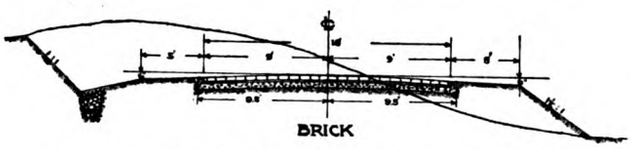
awarded to D. Williams for highway brick block, 20 ft. in width and on 5-in. concrete base with 5-in. curb, at a total cost of $87,500 or $28,226 per mile. The contract included considerable grading. This pavement has been down for almost a year and is in first-class condition, showing splendid wearing quality, no surface cracks appearing.

The Bothell road which was let on same date, was an extension of 3.33 miles to the town of Bothell, of the Seattle-Lake Forest Park road, constructed previously of warrenite and bituminous, on crushed rock base, from the city limits of Seattle to Lake Forest park. This highway was awarded to J. W. Johnson for highway brick 18 ft. in width on 5-in. concrete base with 5-in. curb, at a cost of $84,000, or $25,225 per mile. This is one of the most picturesque drives in the country, practically paralleling beautiful Lake Washington its entire length, and, like the one south of Seattle, has developed a large traffic, and is fast displacing the railroad paralleling it to the town of Bothell, both for freight and passenger traffic. The maximum grade is 4 per cent.

The surface is in splendid condition after one year of service, with the exception of one place where a large fill slipped and settled about three or four inches. The road was graded and graveled the year previous, only having one year to settle. The fill at this point was made on a steep hillside with a hardpan cut on the upper side of 10 ft. or more, and a fill from 20 to 40 ft. on the lower side. A portion of the entire fill moved the first winter after pavement was laid, rupturing at the line of grade of the fill and cut. No repair has been made to date, as it is deemed advisable to give the road another season in which to settle to its final condition.

The road from the north city limits to the Snohomish County line, known as the North Trunk road, was awarded later in the summer of 1913 to Andrew Peterson. This contract consisted of 6.13 miles of highway brick block, 18 ft. in width, on a 5-in. concrete base, and 5-in. curb. The south three miles has to be regraded to take out considerable adverse grade and grades ex-



HIGHWAY SECTION, PART IN CUT AND PART IN FILL.

ceeding 4%, as this has been the standard grade for brick roads.

The cost of this improvement was $149,750, or $24,429 per mile. This road, when Snohomish county improves the connecting link, will be the main highway between Seattle and Everett. The traffic on this road at present is not very heavy owing to the fact that it is not a through highway between any commercial centres. The expected traffic will be multiplied many times when this route is completed.

During the present year, King county, under the supervision of A. P. Denton, county engineer, is building 6.43 miles of brick road. At the present time this work is well under way and will be completed at the end of the year. A total of 5.07 miles is being built by the Permanent Highway fund, and 1.36 miles by county bond issue of $3,000,000. The first of these contracts is an extension of the Redmond road, a trunk highway extending from Seattle easterly over the Cascade mountains to eastern Washington. This is the main highway east and west through the state. The contract for this road was awarded to L. R. Ellis for 1.60 miles of No. 2 pavers, 18 ft. in width, laid on a 5-in. concrete base with 5-in. curb, at a cost of $41,435, or $25,897 per mile. The grading and bridges for this road were completed in 1913, including 6 in. of gravel surface.

LAYING CONCRETE BASE.

The most important work undertaken this year involves the construction of 3.47 miles extension of Permanent Highway 3b, or from Auburn to Pierce county line, when it will connect with a granitoid road to the city of Tacoma. This contract called for No. 1 brick block, pavement 20 ft. in width, laid on a 5-in. concrete base with a 5-in. curb, including a connection to Auburn of about one-half mile built under the same specifications at a total cost of $121,760, or $35,821 per mile. This contract included some very heavy grading and involved a grade separation of the Puget Sound Electric railway and county road.

At the present progress of work, this improvement will be completed in December. This is the last connecting link in the Pacific highway, between Seattle and Tacoma, to be hard surfaced, a distance of about 40 miles. The expected traffic over this highway will justify this expensive piece of road construction. This is probably one of the finest and most costly paved roads in the United States. The third road to be paved this year is from Taylors' mill or city limits of Seattle, southerly for a distance of 1.36 miles, connecting with a bridge on State Road No. 7 near Renton. This improvement is being paid for out of the $3,000,000 bond issue fund. The contract for this road called for No. 1 brick block, 18 ft. in width, laid on a 5-in. concrete base, and 5-in. curb, at a cost of $39,470, or $29,022 per mile. Following is a cost table for brick roads in the state of Washington. It will be noted that 21.74 miles of a total of 24.67 miles is in King county.

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COST OF BRICK ROADS IN WASHINGTON

Including all contracted up to December 31, 1914

Road and location.	Ready for traffic.	Base.	Width.	Brick.	Contractor, county.	Miles.	Contract price, including grading.	Yardage.	Cost per yard.	Cost for 1000 ft.	Cost for 1000 ft., 16 ft. 10 in. basis.	Cost per mile.
Kent, south of Kent.....	Spring 1913	5-in. concrete	16 ft. 10 in.	No. 2 Pavers	T. Ryan, King.....	2.75	$59,524	28,635	$2.08	$4,095.78	.....	$21,625.00
Puyallup, Puyallup	Spring 1913	4 in. concrete	16 ft. 10 in.	No. 2 Pavers	Wash. Pav. Co., King	0.75	18,000	7,405	2.43	4,546.53	.....	24,000.00
Kittitas County, Ellensburg	Summer 1913	4-in. concrete	16 ft. 10 in.	No. 2 Pavers	C. Anderson, Kittitas	1.18	23,500	11,454	2.05	3,833.50	.....	19,915.00
Snohomish, Stanwood.....	Autumn 1913	6-in. concrete	8 ft. 10 in.	No. 2 Pavers	N. W. Ball, Snohom'h	1.00	25,330	11,045	2.29	4,790.00	$4,282.30	25,330.00
South Trunk, Auburn.....	Autumn 1913	5-in. concrete	20 ft. 10 in.	Highway Block	D. Williams, King..	3.10	87,500	37,876	2.31	5,345.00	4,319.70	28,226.00
Bothell Road, Bothell.....	Early in 1914	5-in. concrete	18 ft. 10 in.	Highway Block	J. W. Johnson, King	3.33	84,000	36,780	2.28	4,769.76	4,263.60	25,225.00
North Trunk, No. 85th St..	Early in 1914	5-in. concrete	18 ft. 10 in.	Highway Block	A. Peterson, King...	6.13	149,750	67,706	2.21	4,623.00	4,132.70	24,429.00
Meadows, So. city limits..	Oct. 1913	Macadam	20 ft. 10 in.	Highway Block	T. H. Collins, King..	1000 ft.	.....	.....	...	.....	.....	.....
Pacific Highway, Auburn..	Dec. 1914	5-in. concrete	20 ft. 10 in.	No. 1 Block	Jahn Cont. Co., King	3.47	121,761	42,438	2.67	6,786.00	5,483.08	35,821.00
Snoqualmie, Redmond....	Nov. 1914	5-in. concrete	18 ft. 10 in.	No. 2 Pavers	L. R. Ellis, King...	1.60	41,435	17,725	2.33	4,905.00	4,384.11	25,897.00
Taylors Mill Co. of Seattle	Dec. 1914	5-in. concrete	18 ft. 10 in.	No. 1 Block	N. W. Ball, King....	1.36	39,470	14,990	2.63	5,496.00	4,912.36	29,022.00

Note.—The macadam base road is not included in this summary.

	State.	King county.
Miles	24.67	21.74
Yardage	276,054	246,150
Contract price, including grading	$650,270.00	$583,440.00
Cost per yard	2.35	2.37
Average cost per mile	26,359.34	27,297.05

It has not been definitely decided what other roads shall be paved in 1915.

The proposed improvement of Pacific Highway as shown on the map will involve about 11 miles of new road of which only a small portion of the old alignment will be used. This improvement when completed will give a route between Seattle and Tacoma with a maximum grade in King county of 2%, and Pierce county not much greater, and a maximum curvature of about 20% with the exception of a couple of right angle turns where 60° curves were used.

The old location between south city limits and Orillia was determined by the state. The construction of a new route between these two points will eliminate a bad crossing at the Puget Sound Electric railway, where several accidents have occurred. Two bridges, one of a movable type, across the Duwamish, and a fixed span at Benton Junction, across White river, will be required. The probable cost of this improvement will be close to $330,000.

Method of Construction

It would be impossible to deal in detail to any extent as to the method of construction of these roads, every road presenting its own problems and methods of handling. One of the most common methods of handling material is the use of a narrow-gage equipment.

Concrete base of 5-in. thickness has a proportion of one part cement, three parts sand, and six parts gravel. Washington cement has been used on nearly all work to date. The concrete curb is poured at the same time as the base, making monolithic construction.

Brick surface is laid on 1½-in. sand cushion, and rolled by a 2½ to 3½-ton roller, to imbed the brick in sand and bring the surface to a uniform appearance. Traffic is closed at least 21 days after the completion of the work. Expansion joints are placed in curb line and every 100 ft. transversely. The tests of all materials for 1913 were made by Charles Newhall, of Seattle, and for 1914, by Faulkenburg & Laucks, Seattle.

A few tables compiled by Mr. Newhall follow:

ABSORPTION TEST

Samples.	Absorption, per cent.	Load at first crack.	Maximum load.	Load at first crack in lb. per sq. in.
1	3.86	68,000	125,000	4.260
2	2.91	72,000	209,000*	4.145
3	0.48	82,000	209,000*	4.960
4	0.47	104,000	209,000*	6.580

*Exceeds limit of testing machine, 209,000 pounds.

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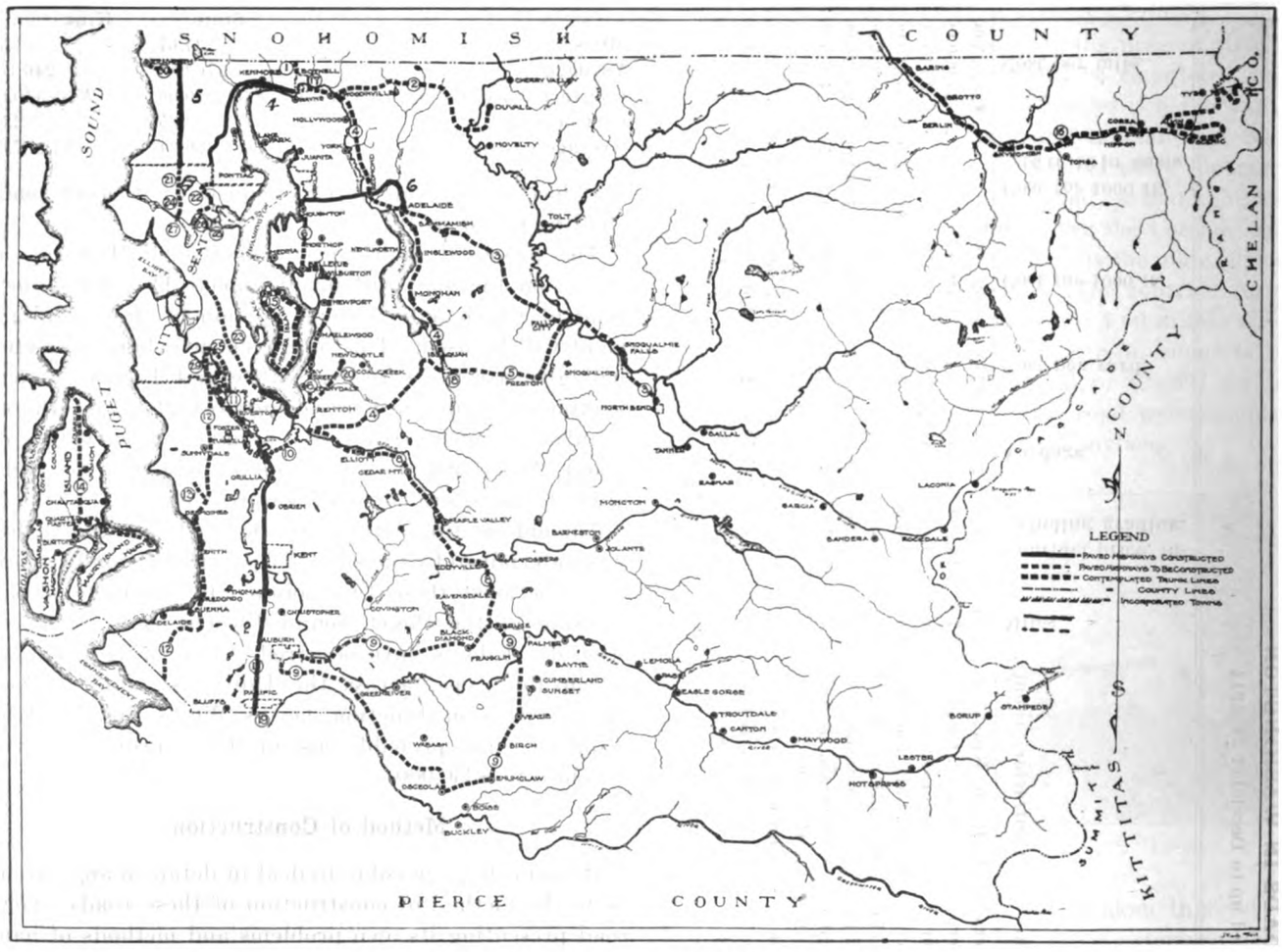

MAP OF HIGHWAYS INCLUDED IN $3,000,000 BOND ISSUE.

Absorption, after standing 24 hours in cold water:

MODULUS OF RUPTURE

Mark.	Dimensions, in. Height.	Width.	Length.	Span.	Load.	Modulus of rupture.
1	3.94	2.33	8.49	6	9,975	2,460
2	4.04	2.29	8.37	6	12,350	2,970
3	3.89	2.40	8.51	7	7,920	2,290
4	4.03	2.37	8.42	7	8,550	2,330

Average modulus of rupture, 2512 lb. per square inch.

Requirements of American Society for Testing Materials, 400 pounds.

GROUT MIXTURES

Mixed in parts by volume.	Age in days.	Tensile stress in lb. per sq. in.
1 cement, 1 sand.....	40	650
1 cement, 1½ sand.....	40	560
1 cement, 2 sand.....	40	445

Test of Brick Beams

Each beam was tested on a 42-in. span, centre to centre, and the load applied at the centre of the span. The beams were placed in the testing machine with the wearing surface up, on which surface the load was applied. The ends of the beams rested on rocker supports, and plaster of paris was used to secure an even bearing at all contact points. A deflectometer was used to record the amount of deflection in the beam at the instant of failure. With the 1-to-1 grout the plane of failure cuts right across one brick and for the rest of the way, through the bond. In one instance a lug was sheared off. With the 1-to-1½ grout the failure in one case was across two brick and the rest of the way through the bond. In the second case the failure was through the bond all of the way. With the 1-to-2 grout the failure was entirely through the bond in each in-

RESULT OF BEAM TESTS

Beam No.	Dimensions of beams, in.: Height.	Width.	Span.	Deflection at maximum load, in.	Maximum load, lb.	Modulus of rupture, lb. per sq. in.	Cement-sand mixture.	No. of bricks ruptured.
1	4	12	42	0.037	3290	1080	1:1	1
2	4	12	42	0.038	3000	984	1:1	1
3	4	12	42	0.043	3015	989	1:1	1
Average				0.039		1018		
4	4	12	42	0.026	2800	918	1:1½	none
5	4	12	42	0.020	2615	857	1:1½	2
Average				0.023		887		
6	4	12	42	0.030	2410	790	1:2	none
7	4	12	42	0.034	2350	771	1:2	none
Average				0.032		780		

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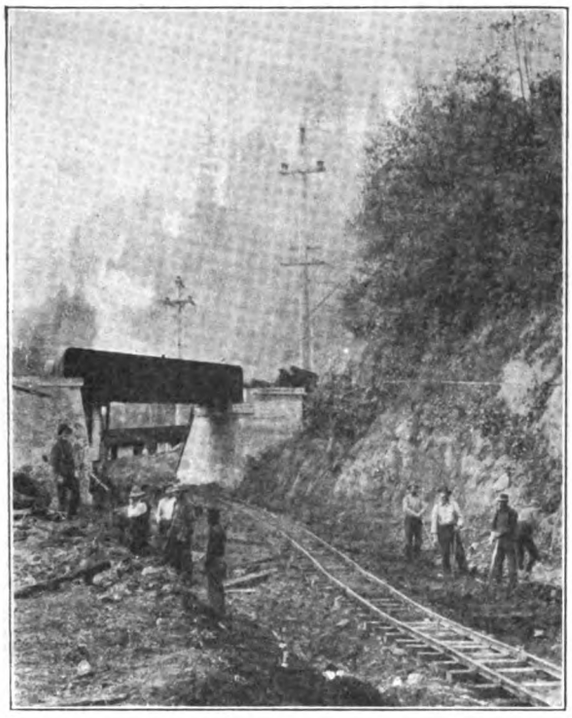
stance. In no instance is the failure through the grout. It is always through the bond, across the grout, or through the brick.

Taylor & Thompson (Concrete Plain and Reinforced,



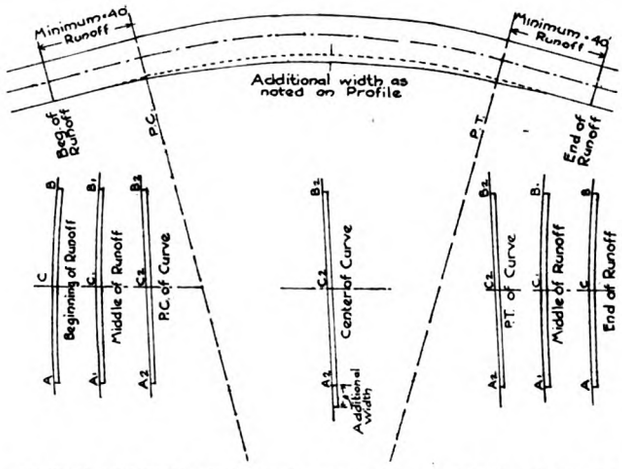
PARTLY COMPLETED GRADE AND RAILROAD UNDER-CROSSING.

Page 376, 1909 edition) gives the following values for the modulus of rupture of plain concrete beams 30 days old:

For 1-2-4 mixture the modulus of rupture is 439 lb. per square inch.

For 1-3-6 mixture the modulus of rupture is 226 lb. per square inch.

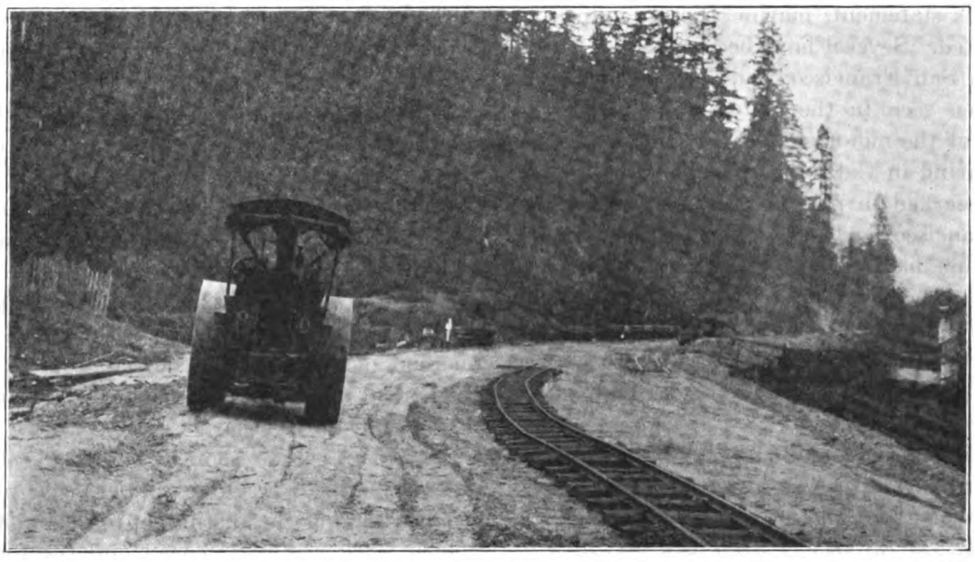
I think this bears out the value of grouting 1-to-1 instead of leaner mixture, or the use of paving pitches. According to the above figures, the brick surface is dependable to distribute the loading over a larger area on the foundation. A base greater than 5-in. becomes a necessity only in exceptional places where soil of roadbed is soft and undependable. All curves greater than 5° are super-elevated and additional width given on inside curve. This method is shown below. The additional width for curvature varies from 1 to 2 ft. as conditions justify. The additional width is figured



SKETCH SHOWING SUPER-ELEVATION AND WIDENING ON CURVES.

as a parabola starting at point of runoff, using the tangent and curve as the base line of offsets. A portion of the centre of the curve has a uniform additional width. This method does not give a true curve, but only an instrument could detect any irregularity.

The super-elevation is a standard from the State Highway Department. The drawing is practically self-explanatory, except for the amount of super-elevation. This is generally twice the crown of roadbed. It is to be noted that at point of runoff, the standard roadbed is used, and middle of runoff the outer edge is raised to the height of crown, making a level pavement on outer half of roadbed. At the point of curvature the full height of super-elevation is gained. The crown is entirely removed from the curve.



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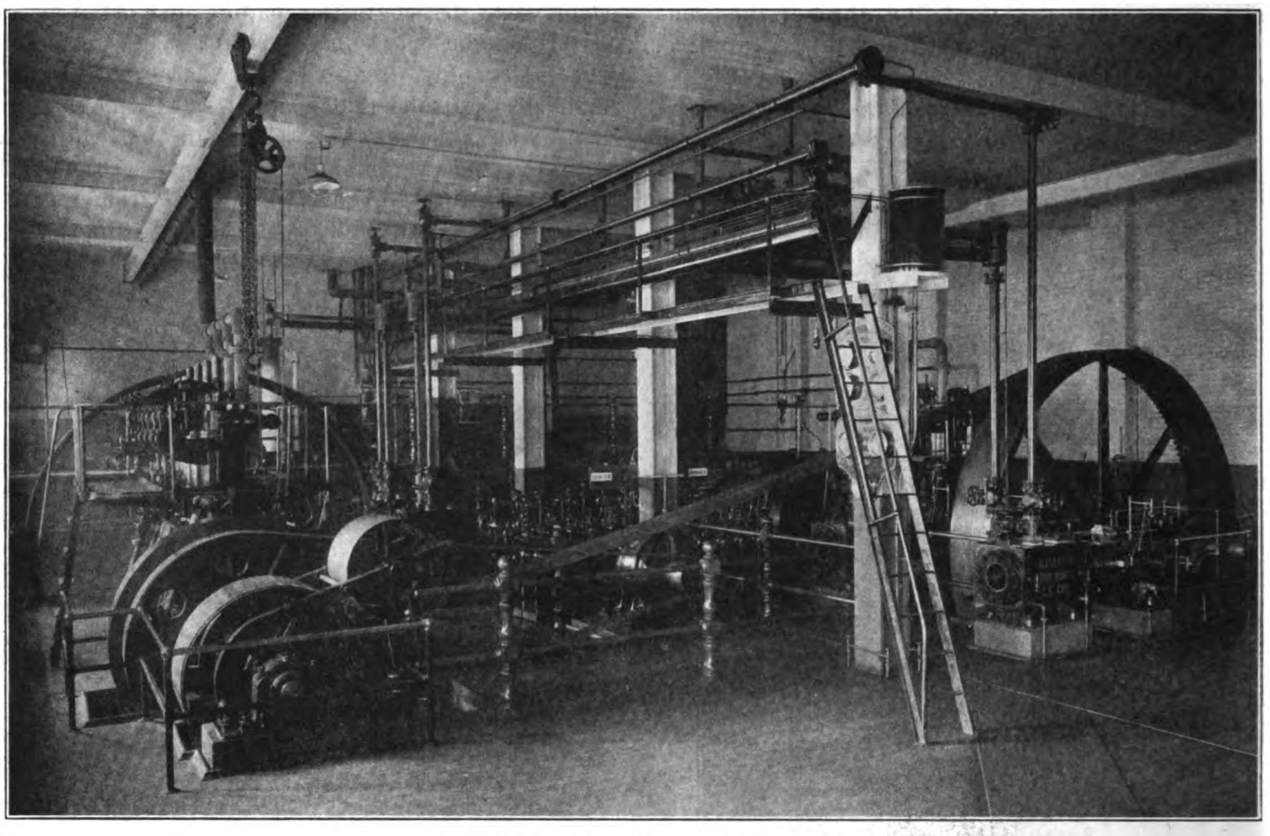

FIG. 1. VIEW OF ENGINE-ROOM.

California's First Diesel Engine Plant

By GEORGE K. DAVOL*

Although two of the earliest Diesel engines imported into this country for commercial use were installed, in 1902 and 1903, in plants west of the Rocky Mountains, and not very far from the California state line, the plant herein described, erected in 1914, contains the first two stationary Diesel engines ever sold for commercial use and set up in the state of California.

In making this statement, marine Diesel engines are purposely excepted. Several have been installed in submarines built in San Francisco, and some very fine examples have been seen in the motor ships which, following the visit of the motor ship *Siam* in January last, have been appearing in California ports.

It may be remarked in passing, that there will have been in San Francisco harbor, by the end of January, seven motor ships having Diesel engines aggregating over 20,000 hp., and a regular monthly service by one line of motor ships has been inaugurated. In March the most powerfully engined mercantile motor ship in the world, the *Fionia,* with Diesel engines of 4000 hp., is due in San Francisco.

The marine application of the Diesel engine, however, should not be confused with its application to stationary use, as most considerations involved are distinctly different; although in point of reliability, its success in the marine field would seem to leave little to question regarding its dependability for stationary use.

In 1902 the first of the two stationary Diesel engines above referred to was installed by the Southern Pacific company at its shops at Ogden, Utah, and the second was set up in its shops at Tucson, Arizona, in 1903.

These two pioneer engines did not prove a practical working success and they were shut down and taken out in the year 1907. Their record is chiefly of interest now as forming a marked instance of the vital effect which matters of detail, whether of design and manufacture, or of handling, have upon the final showing of a high-grade mechanical construction. The fundamentals involved in the Diesel engine of that date are the same as those involved today, but the intervening years have apparently been required to bring about that development of detail, and of understanding, and to make the necessary commercial demonstration required to start the active and successful application of the Diesel engine to stationary use on the Pacific coast.

There are at present in California two commercial Diesel plants in regular service; the plant herein described having the distinction of being the first one on which work was commenced and the first one to be in

*Consulting Engineer, 503 Market street, San Francisco.

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operation. This plant was installed at Battery and Union streets, San Francisco, by the National Ice & Cold Storage Co., for which in connection with this installation the writer acted as consulting engineer. This plant comprises two Diesel engines of 200 hp. each and has been in regular daily service since the middle of August last. A brief record of some of the features of the installation may prove of some interest.

The Diesel engine is now generally understood, but for the benefit of those not informed it may be briefly stated that it forms today the most efficient heat motor in existence, being capable of transforming into useful and available power approximately one-third of the total heat value of the fuel used. It not only has this high thermal efficiency, but it is capable of using as fuel, oils of comparatively low grade and low cost.

It is principally to be distinguished from other internal combustion engines by two characteristic features, which are, first: a very high compression of pure air within the cylinder; and, second, the spraying of the fuel into the cylinder through an atomizing fuel valve by means of injection air of **still higher pressure**; the injection of the fuel occurring at about the point of highest compression, or at the end of the compression stroke. In normal operation, compression of air within the working cylinder is carried to about 500 lb. per sq. in., by which degree of compression the air is heated to a temperature which may range anywhere between 840° and 1000°F. or even somewhat higher, depending upon the temperature of the cylinder walls and other parts and certain other conditions. The fuel is then sprayed into this highly heated charge of air by injection air supplied by a two or three-stage compressor driven by the engine; and which injection air may range in pressure from approximately 600 to over 1000 lb. per sq. in., depending upon the load carried by the engine.

The fuel ignites and burns as it enters the highly compressed and heated air within the cylinder, and cumbustion is supposed to be approximately completed when the period of fuel injection ends. The pressure of compression therefore constitutes the highest pressure of the cycle; there is normally no rise of pressure during combustion.

Three typical indicator diagrams taken from one of these engines in the plant under description, at three-fourths, full, and about 10% overload are reproduced in Fig. 2. Referring to the upper diagram, the line from *a* to *b* shows the compression which reaches 500 lb. per sq. in.; from *b* to *c* the fuel is sprayed into the cylinder, igniting and burning as it enters. The point *c*, marked in all the diagrams, is the point of closing of the fuel valve, and occurs at the same point of the stroke of the piston, regardless of the load. From *c* to *d*, expansion of the gases occurs, and at *d* the exhaust valve opens and the gases are exhausted on the stroke from *d* to *e*. From *e* to *a* the inlet valve is open and a new charge of air drawn into the cylinder.

The characteristics of Diesel engine diagrams can be considerably altered by slightly shifting the period of fuel supply. In the diagrams shown, the fuel valve opens about 5° before the crank is at upper dead centre, and closes when it is about 40° past the centre. An earlier setting, which terminates the fuel admission earlier in the stroke, produces a diagram with a flatter or less pointed top and theoretically tends toward a higher thermal efficiency, but it can be argued that it may also tend to greater water jacket and frictional losses. The question is wholly one of cam setting and adjustment, for which experimental results with each engine are the best guide. The diagrams shown are se-

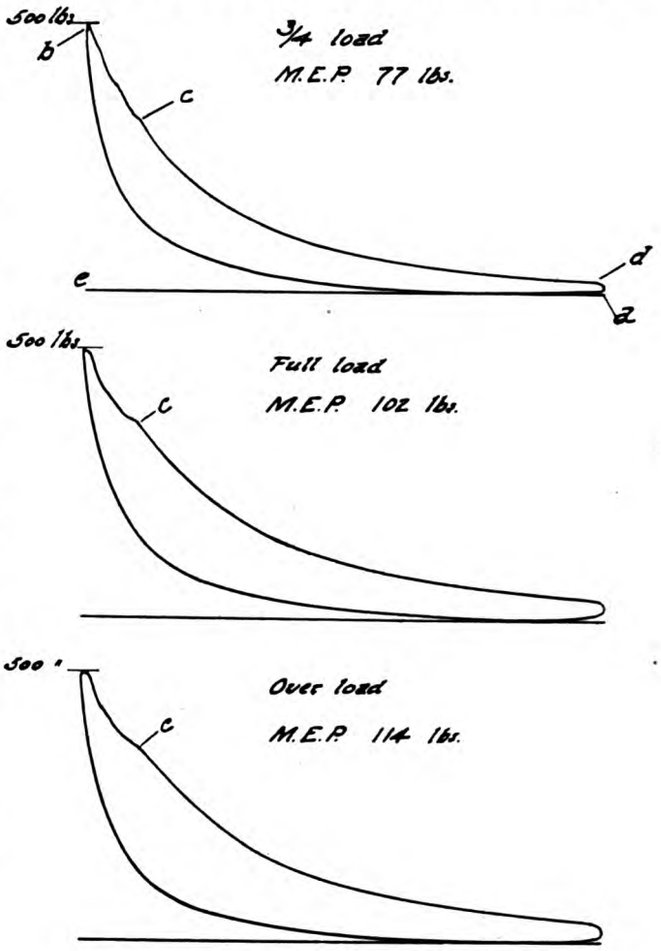

FIG. 2. TYPICAL INDICATOR DIAGRAMS.

lected from those taken during a test run when the engine was running very smoothly at all loads and showing a thermal efficiency based on the brake horse-power which ran as high as 33 per cent.

The power requirements of a large ice-making and cold-storage plant are in some respects very rigid, as while the load is fairly constant there must be no material interruption of service; as very large financial losses may result from losing for a few hours control of the temperatures in the cold storage rooms. This would result from any serious breakdown or failure of the power service. It therefore demanded an intelligent weighing of all conditions involved and a strong confidence in the reliability of the Diesel engine, before their

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selection as the sole source of power for this new plant was decided upon. The pronounced saving, however, which their successful installation promised, led Joseph Martin, of the National Ice & Cold Storage Co. to start a careful investigation, and in this he was assisted by Frank P. Whippel, of the Company, who made a tour of investigation which covered most of the important Diesel engine plants in the country. Their final advocacy of the Diesel engine for this plant was acted upon and the engines were ordered.

65-kw. capacity which supplies electricity for all lighting and power purposes ordinarily demanded throughout the plant; so that under normal conditions the plant is entirely independent of any outside service save that of fresh water for ice-making.

A view of the end of the engine room, showing the two units so far installed, is given in Fig. 1, and a plan of that portion of the room is covered in Fig. 3. In the photographic view, the Diesel engines are less prominent than the ammonia compressors and accessories,

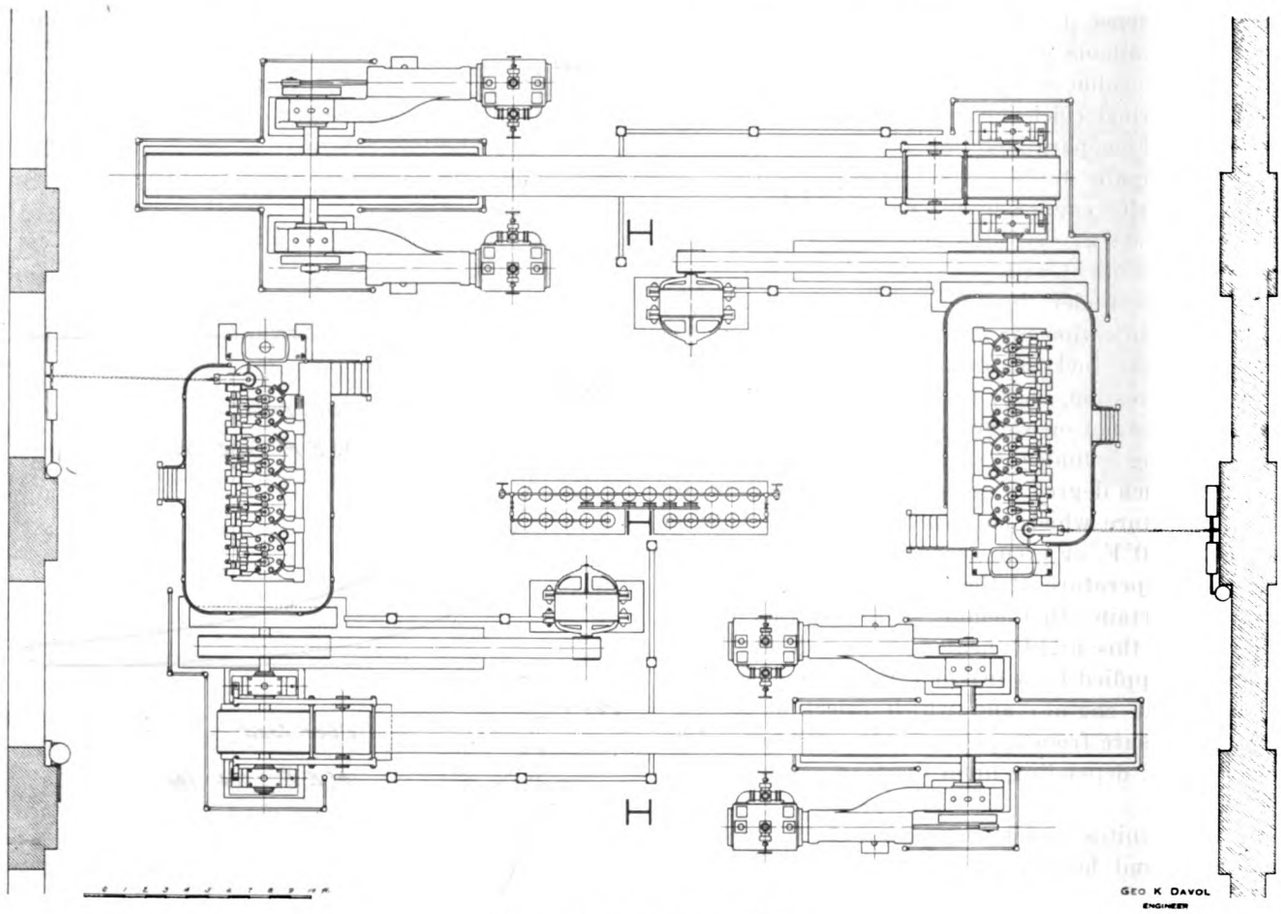

FIG. 3. PLAN OF ENGINE-ROOM.

The plant as at present installed has an output of 120 tons of ice per 24 hours and very large cold-storage capacity; and covers at present half a city block, with provision for extensions which are intended to eventually cover the entire block. It is beyond question the most modern and completely equipped plant of the kind in California.

The engines so far installed comprise two units of 200 b-hp. each. They were supplied by the Dow Pump & Diesel Engine Co. of San Francisco and are known as Dow-Willans engines, being built under license from and after designs of Messrs. Willans and Robinson of Rugby, England. They are each belted to a two-cylinder double-acting horizontal ammonia compressor, which was supplied, together with the entire ice-making and cold-storage system, by the Cyclops Iron Works of San Francisco.

Each engine is also belted to an electric generator of

which form the bulk of the machinery in evidence.

The arrangement of machinery adopted, which is shown clearly on the plan view, was not open to any alternative choice. The building had been planned and the dimensions of the engine room fixed to accommodate electric motors and compressors, and into this space the same compressors with Diesel engines instead of electric motors had to be placed, which, however, has been accomplished without any serious inconvenience or overcrowding. One-half of the engine room is still unoccupied and is reserved for future units.

The engines are 4-cylinder, four-cycle vertical Diesel engines of the 'A' frame and trunk piston type, and conform in their general features and details to lines which have been extensively followed for a number of years by certain European manufacturers. The marked survival of this design without fundamental change may

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be regarded perhaps as showing a certain degree of fitness for the service to which this type and size of engine may be properly applied.

The principal dimensions of the engine are in metric measurement, but the cylinder diameters closely approximate 12 in. and the stroke 18 inches.

The normal speed of the engine is 250 r.p.m., but this speed can be adjusted over a range of 10% above and below normal by hand adjustment of the governor while running.

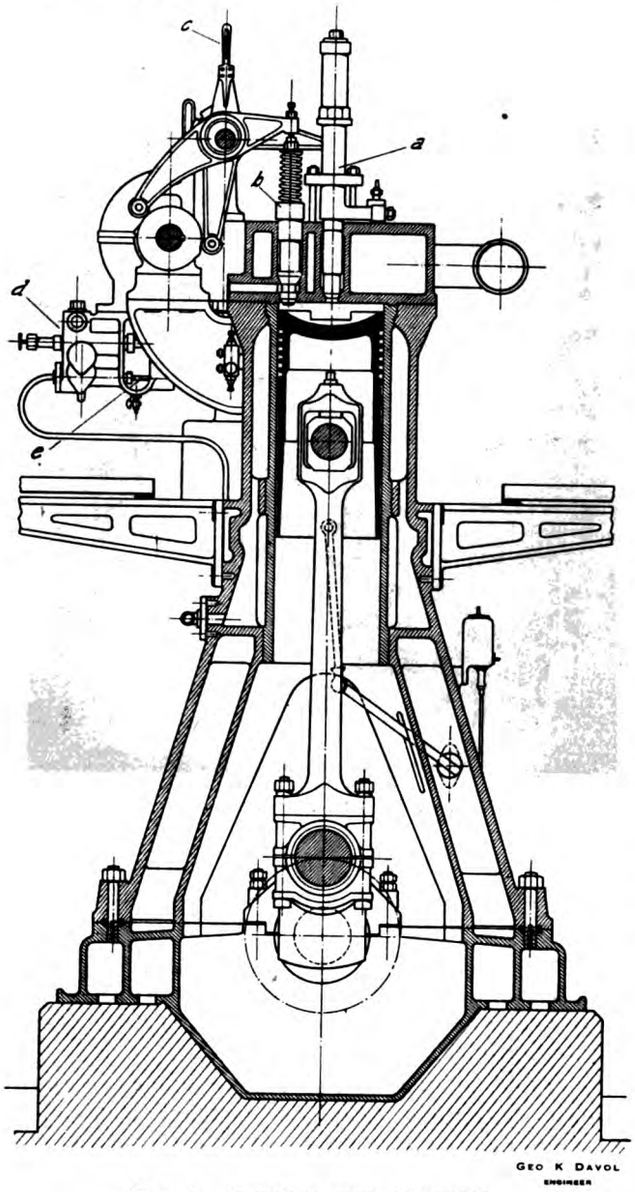

FIG. 4. SECTIONAL VIEW OF ENGINE.

The fly-wheel is a solid disc and is 7 ft. 1 in. outside diameter, which gives a peripheral speed at the outside of the rim of 94 ft. per second. The rim weighs approximately 6000 lb. or about 24 lb. per rated horse-power, which weight and rim speed in connection with the even torque supplied by the four cylinders results in an exceedingly close cyclic regulation of speed.

A sectional view through one of the cylinders of the engine is shown in Fig. 4 and a photographic view of the front of the engines is clearly illustrated in Fig. 5.

In Fig. 4 the section through the cylinder head shows the fuel valve *a* in the centre and the starting valve *b* at one side. The inlet and exhaust valves are not shown in this view. They are arranged in the usual manner on either side of the fuel valve.

The fuel is supplied to the four fuel injecting valves, by a single fuel pump *d*, Fig. 4, which makes on delivery stroke for every revolution of the engine and forces the fuel through a 'distributing box,' from which it flows in four separate pipes to each of the fuel valves over each cylinder.

The function of the distributing box is to divide the fuel delivered by the fuel pump into four equal portions and divert each portion to one of the cylinders. This is accomplished by adjustable needle valves, the clear orifices through which by adjustment are made equal. The resistance encountered by the oil in passing these constricted orifices is relatively so much greater than the other minor resistances of the piping, etc., that the quantity passing to each cylinder is proportionate to the clear area through them. When these needle valves are once adjusted properly they should normally require no further attention.

The final proper adjustment of this fuel distribution is accomplished by taking indicator diagrams from all the cylinders and adjusting the needle valves until the cylinders all show equal mean effective pressures. This method, however, while it furnishes the final proof of proper adjustment, is not always necessary, as experience has enabled the engineers to make this adjustment with remarkable accuracy by judging the relative strength of the exhaust from the different cylinders. Once the engine has been brought to satisfactory running condition, this adjustment should, of course, not be changed or normally require further attention.

This method of fuel supply to the cylinders is to be contrasted with the alternative method sometimes employed which consists of using a separate fuel pump for each cylinder. For any but the very largest sizes of engines, it would hardly seem that any advantage can be claimed for the separate fuel pump method. The use of separate fuel pumps certainly results in much greater complication and number of parts, while the pump, being of smaller capacity, becomes naturally much more liable to derangement of action by air bubbles and leakages. The fuel pump or pumps of a Diesel engine are most vital parts and must operate with certainty under most onerous conditions. They are in the usual designs required to deliver a measured quantity of fuel to the fuel valves against the full pressure of the injection air, which may range around 1000 lb. per sq. in., consequently the reduction of the number of such fuel pumps would seem a very desirable end.

The governing of the speed of the engine is effected by varying the amount of fuel delivered by the fuel pump. This is accomplished in these engines by holding open the suction valve of the pump during a variable portion of the delivery stroke of the pump plunger

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and so utilizing a greater or less proportion of the full pump capacity. A reciprocating plunger which acts upon the pump suction valve, shown at *e* in Fig. 4, has the timing of its stroke regulated by the governor, which in this manner regulates the speed of the engine.

The fuel used in this plant is supplied by the Standard Oil Co. and is known under the commercial name of 'Star Fuel Oil.' It is a mixture designed to possess those characteristics most suitable for a Diesel engine fuel. This fuel can be obtained in the vicinity of San Francisco at a very moderate advance over the price of ordinary fuel oil, and its use eliminates all question regarding quality of oil, or adaptability of the engines to varying qualities of ordinary fuel oil.

A determination of the qualities of this fuel was made by sampling the oil in the main storage tanks at the plant, into which it is run directly from tank cars, with the following results:

Specific gravity (23.93 Baumé)	0.9095
Water, per cent	0.08
Sand	none
Flash point (open cup)	212°F.
Burning point	235°F.
Viscosity (Tagliabue, water = 60)	81.6
Sulphur, per cent	0.44
Asphalt, per cent	11 to 23*
Heat value lower (water uncondensed), B.t.u.	18,407
Heat value higher (water condensed), B.t.u.	19,649

*See explanation.

The determination arrived at for the asphalt content was rather uncertain and unsatisfactory, but this oil is commonly reported to carry about 21% of asphalt.

The uncertainty of the asphalt determination as above stated was due to the varying quality of the asphalt obtained from several tests; the variation in quantity being probably further enhanced by a lack of exact uniformity in the methods followed. In view of the importance which the percentage of asphalt in oil assumes in connection with its use in Diesel and other oil-engines, it may be remarked, in passing, that under the present absence of any universally recognized standard procedure for determining the asphalt content of an oil, and the lack of specified qualities of the asphalt so determined, the mere unqualified statement of percentage of 'asphalt' in oil means very little and may be very misleading.

The procedure for asphalt determination and grading which is commonly specified in connection with its use for road purposes, covers the distillation of the oil in an oven at 400°F., cooling the residue to 32°, reheating it very slowly in a water bath to 77°, and testing it in the bath or in a room of that temperature for hardness by a standard form of penetrometer. This instrument forces a No. 2 sewing needle under a load of 100 grams for 5 seconds into the surface of the asphalt sample. The degree of penetration shown by the needle determines the hardness or 'grade' of the asphalt. The Standard Oil Company has, for example, adopted a grade of asphalt showing a penetration of from 2.6 to 8 millimetres, as above determined, which is known as 'D grade,' for the basis of the ordinary statement of the percentage of asphalt in oil.

Such a specific method and standard of grading, if universally adopted and closely followed, would end the present lack of definite meaning in speaking of percentage of 'asphalt' in oil.

This grade of oil which has been adopted has proved very satisfactory as a fuel in these engines, the combustion being practically perfect and the exhaust normally literally invisible. Whether a heavier oil would prove a satisfactory fuel or not is a question on which the operation of this plant throws no light. Under the present local conditions of relative price, and the undoubted greater care and precautions which the use of any heavier oil would entail, there is little inducement to consider any change of fuel.

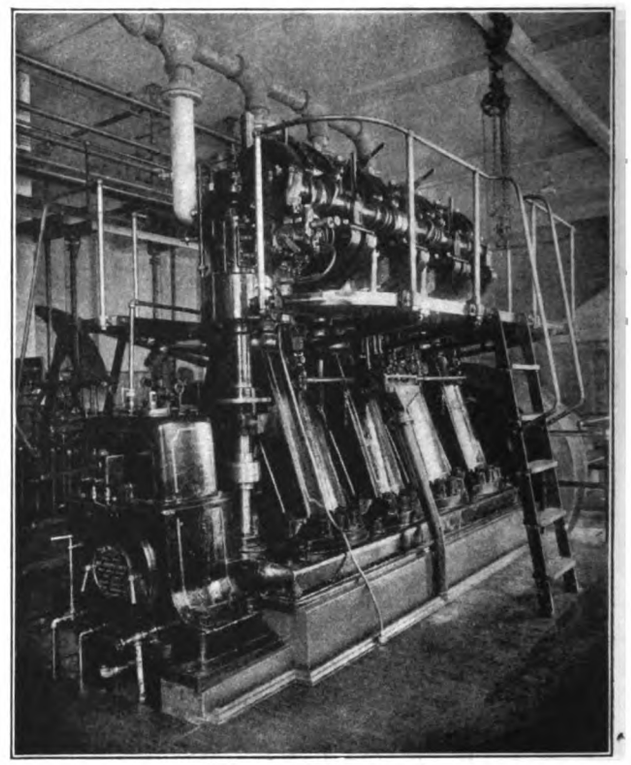

FIG. 5. FRONT OF ENGINE.

The system of fuel supply to the engines necessarily involved departures from the methods followed in supplying fuel oil to boiler and other furnaces, and the principal features of this system as finally installed were accepted and made a standard by the local Board of Fire Underwriters for future Deisel and other oil-engine plants in San Francisco.

This fuel supply system is very simple, and comprises two underground storage tanks of 300 bbl. nominal capacity each, which receive the oil direct from tank cars. From either of these storage tanks the oil is drawn by a small gear pump direct connected to an electric motor, and is elevated to an enclosed riveted steel cylindrical tank on the engine-room wall. From this tank the oil flows under a gravity head to

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the engine's fuel pumps, which it reaches under a pressure of about 5 lb. per square inch due to the gravity head. The surplus from the gravity tank overflows and returns to the main storage tank from which it was drawn; so that there is circulated and returned to the main storage tanks about twice as much fuel as is used in any given period. No pressure except that due to gravity can be placed on the engine-room wall

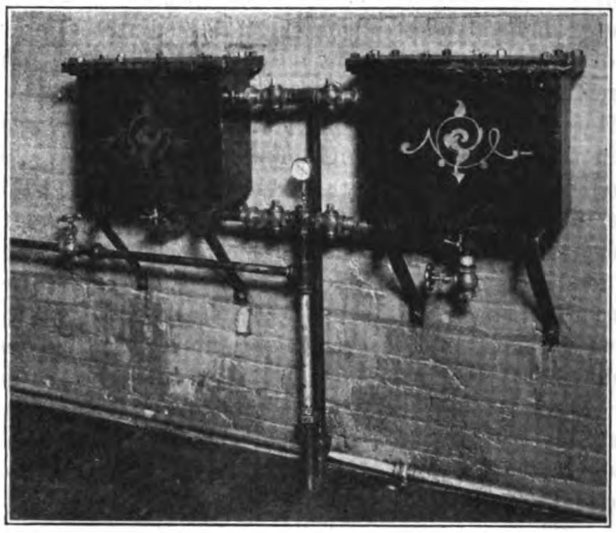

FIG. 6. FUEL OIL FILTER.

tank, but the tank is made tight and tested to 100 lb. per square inch. This gravity tank can, if desired, be by-passed and the fuel supplied direct to the engines by the gear pump at any desired pressure up to 60 lb. per sq. in., but no occasion has yet arisen for utilizing this feature.

Before reaching the engines the fuel is passed through filters to remove any dirt or foreign matter. These fuel-oil filters, of which there are two for each engine, are placed close to the engines and are arranged so that one can be cleaned while the other is in use. One pair is shown in Fig. 6. The essential feature of these filters consists of a central frame on which about ¼ in. thickness of felt is held, through which the oil is forced to pass. Since the plant has been well started, covering a period of about three months, there has been no evidence of any need for cleaning or opening any of these filters, which speaks well for the cleanliness of the oil. During the starting-up period of the plant a sudden slowing of one of the engines indicated a clogging of one of the filters, which was opened, and a large and 'perfectly good' second-cut file, covering the delivery orifice, was extracted.

The fuel is injected into the cylinders by being forced through atomizing devices in the fuel valves by highly compressed air. The proper pressure of this injection air depends upon the nature of the oil and the amount that is to be forced in: or, in other words, on the load which the engine is carrying. For the engines in question, with the fuel which is being used, the pressure of the injection air is varied from about 560 lb. per sq. in. for no load to about 975 lb. at full load. Too low a pressure of injection air at heavy loads results in insufficient atomization of the fuel and incomplete combustion, while too high a pressure at light loads is apt to cause delayed and irregular ignition, and misfires.

These engines use an atomizing fuel valve of the type shown in Fig. 7, which only depicts the atomizing device and the end of the valve and its seat.

The central stem *a* forms the valve, which normally rests in its seat *b*. This valve stem passes through a cone *c*, having about twenty small grooves *d*, on its outside surface, which form passages for the atomized oil and air. Above the cone a number of perforated washers *e* are placed, with the perforations staggered in the manner shown. The fuel oil is supplied through the small passage *f* by the fuel pump, and spreads over the upper surface of the washers. The injection air is supplied through the annular space *g*.

When the fuel valve is raised off its seat, the high pressure injection air forces the oil through the perforated washers and passages *d*, and out through the final orifice in the flame plate *h* into the combustion space of the engine cylinders below. The oil being forced with such extreme velocity through these tortuous passages, becomes very finely divided and mixed with the injection air, and issues in the form of an oil mist, which ignites and burns as it enters the cylinder.

The form of atomizing valve is a feature which in Diesel engines is open to a great variety of design,

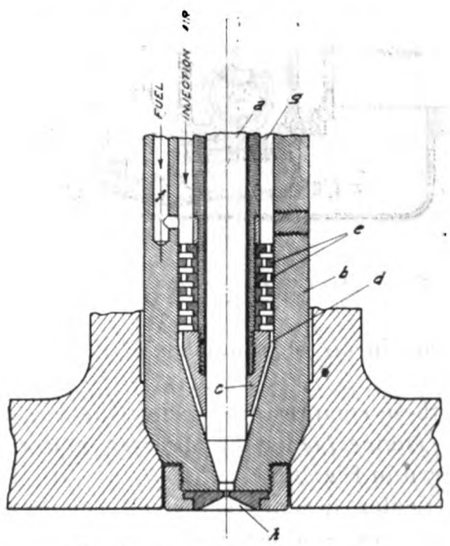

FIG. 7. FUEL INJECTOR VALVE.

but the form shown constitutes one of the oldest and most thoroughly demonstrated types.

It may be of interest to report that one of these engines has run for a brief period under no load, with a pressure of injection air as low as 450 lb. per square inch. This pressure is actually below that of the compression within the cylinder, but the action can be

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understood when it is realized that during the expansion stroke the pressure within the cylinder would drop very greatly before the fuel valve closed.

The means of supplying this high pressure injection air, which in most Diesel engines is also used for starting, forms a most important and vital feature of the engines. In these engines the injection and starting air is supplied by a three-cylinder, three-stake compressor operated from an overhung crank on one end of the engine crank-shaft. These compressors were made under license by the Dow Pump & Diesel Engine Co. from designs of Reavell & Co., of Ipswich, England, whose compressors have been very extensively adopted by Diesel engine manufacturers in England and Europe, and are in use on a number of the largest motor ships.

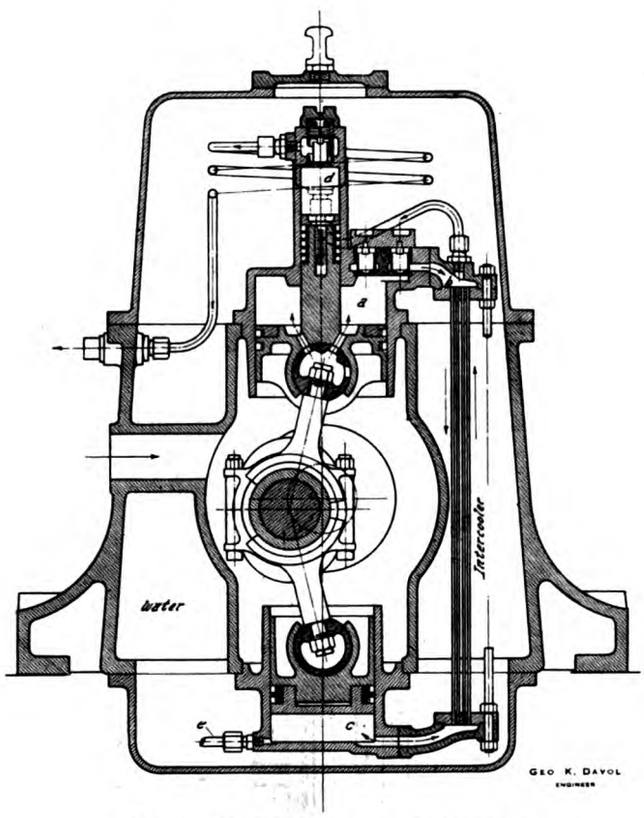

FIG. 8. SECTIONAL VIEW OF COMPRESSOR.

One of these compressors is shown in Fig. 5 on the end of the engine facing the observer, and a sectional view is shown in Fig. 8.

The particular design of Reavell compressor used on these engines is a new one and possesses certain novel features which may justify a somewhat detailed description. It may be remarked at starting that the principal features of Reavell compressors have always been, in all designs which the firm has put out: first, the radial disposition of a number of single-acting cylinders around a central crank; and second, the admission of air to the low-pressure cylinders through ports in the gudgeon pins or wrist pins. This construction has supplied a mechanically operated inlet valve without any addition to the number of parts.

The former and well known designs of Reavell compressors, however, have had all cylinders except the low pressure supplied with the usual inlet and delivery valves, and have been provided with the usual intermediate receivers and disposition of intercoolers between the stages. The compressors built to this new design, on the other hand, embody a skillful utilization of the effect of cylinder clearance, to avoid the use of any valves at all on the intermediate cylinder, and to avoid likewise the necessity for intermediate receivers.

Referring to the sectional view, Fig. 8, it will be seen seen that the low and high-pressure cylinders are arranged in tandem above the overhung crank pin, while the intermediate cylinder is disposed in line beneath the shaft. This arrangement at first sight would seem to load the crank pin unequally or cause more pressure to come on it during the up stroke than on the down stroke. In this compressor, however, it is possible relatively to proportion the cylinders so that the work done by the intermediate piston be equal to that done by the high and low-pressure pistons combined, without impairment of efficiency, which such proportions would entail under ordinary conditions of design. This will be more fully explained.

The air is drawn into the enclosed crank case through the opening at the left and passes, during the down stroke, through the ports in the gudgeon or wrist pin, and piston into the low-pressure cylinder *a*, as shown by the arrows. During the up stroke this air is compressed and forced through the delivery valves in the top of the low-pressure cylinder into the passage *b*, which is in free open connection with the intercooler and intermediate cylinder *c*. On the succeeding down stroke this air, trapped within the intercooler, intermediate cylinder, and connecting passages, is compressed further by the descending intermediate piston, and is **simultaneously cooled** in the intercooler. During the latter part of this stroke a portion of this air is delivered through an inlet valve into the high-pressure cylinder *d*. The succeeding up stroke gives the air within the high-pressure cylinder its final compression and it is delivered through the final delivery valve shown, into a coil aftercooler and led to the air-storage bottles.

A theoretically constructed combined indicator diagram is shown in Fig 9, which makes more clear the peculiar and distinctive action of this compressor.

In this diagram the pressures are indicated in atmospheres and the final pressure taken, 69 absolute atmospheres, is about the maximum pressure of delivery, when the compressor is charging the starting-air bottles.

It may be said in advance of further explanation, that the desired action in this compressor is brought about largely through a proper relative proportioning of clearance in the intermediate and high-pressure cylinders; the clearance of the intermediate cylinder in-

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cluding, of course, the entire volume of the intercooler, and the connecting passages; and a moderate variation in these clearances will produce marked changes in the combined diagram such as shown in Fig. 9.

Referring to Fig. 9, the air is compressed in the low-pressure cylinder from *a* to *b*, at which point the pressure of the expanding air in the intermediate clearance meets that in the low-pressure cylinder, and during the remainder of the stroke the whole volume of the air within the low-pressure cylinder, intermediate cylinder, intercooler, and passages is compressed on the line from *b* to *c*. The succeeding compression stroke by the intermediate piston follows the line from *c* to *d*,

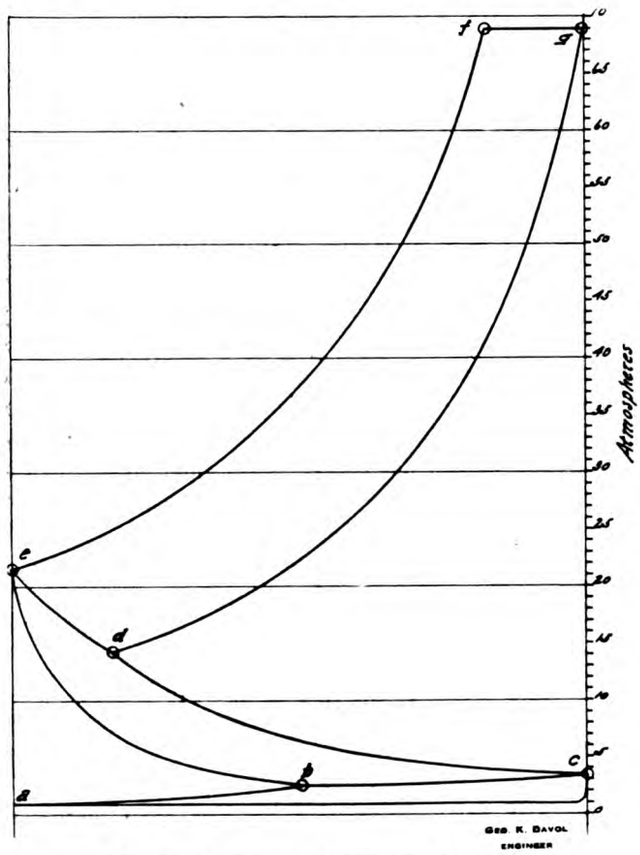

FIG. 9. COMBINED COMPRESSOR DIAGRAMS.

where in like manner the pressure of the expanding air of the high-pressure cylinder clearance meets that in the intermediate cylinder, and during the remainder of the compression stroke of the intermediate piston the air in both high and intermediate cylinders and clearances is compressed on the line from *d* to *e*. Compression in the high-pressure cylinder follows from *c* to *f*, with delivery from *f* to *g*.

It will be seen that the beneficial action of the intercooler takes place on the compression line *b*—*c*—*d*—*e* and that consequently the compression shown by this line is probably very far from being adiabatic, while the compression lines *a*—*b* and *c*—*f* in low and high-pressure cylinders, respectively, probably closely approach the adiabatic line. It consequently follows that the efficiency of the compressor will be favorably affected by increasing the compression ratio in the intermediate cylinder, relative to that in the low and high cylinders. Such a relative increase of compression ratio throws more work on the intermediate stage and has the favorable mechanical effect of rendering more uniform the crank-pin pressures, which point was first above referred to.

In the typical diagram, Fig. 9, the clearances taken for intermediate and high-pressure cylinders are such that the compression ratio and work done in the intermediate stage is equal to that of the low and high stages combined. If this diagram be corrected for piston areas, then the area of the intermediate stage, namely, *c*—*d*—*e*—*b*, will be found to be approximately equal to that of the two other stages combined. The diameters of the cylinders in this compressor are: low-pressure, 10 in.; intermediate, 8 in.; and high, 3 in.; with a common stroke of 5 inches.

The proper regulation of clearances in this compressor is a matter which sometimes involves some experimental adjustment, for which suitable provision is made. An increase of clearance in the high-pressure cylinder reduces the compression ratio of the third stage and throws more work on the intermediate stage, and *vice versa*.

The pressure of injection air carried is regulated by varying the amount delivered by the compressor. This is accomplished by opening a vent or 'blow-down valve,' which establishes free connection between the intermediate cylinder and the atmosphere. This connection is shown at *e* in Fig. 8, and the handle by which the blow-down valve is regulated is plainly shown on the front of the compressor in Fig. 5. The opening of this vent allows, of course, a portion of the air in the intermediate cylinder to escape and so reduces the delivery of the compressor. The loss in efficiency which this means of regulation entails is not material, and with the present experienced handling, it is possible to set this regulator for any desired pressure without having to readjust it during an 8-hour watch.

The piping connections of the air storage bottles and injection air bottles are particularly arranged with suitable throttling connections, so that air can be charged at 1000 lb. pressure into the starting air bottles while it is being supplied to the injection air bottles at any lower pressure desired.

The full capacity of each compresssor is about 51 cu. ft. of free air per minute, which gives a maximum allowance of about 15 cu. ft. of air per rated horse-power per hour, which seems a fair average for such engines.

From the compressors the air is carried to the steel air bottles, Fig. 10. Of these air bottles there are twenty-two, each having a capacity of 1.73 cu. ft. Twenty of the bottles are arranged in four separate banks of five bottles each, and constitute the storage capacity for starting air; the two remaining bottles, one at each end of the front row being for the injection air.

It is customary to carry the four banks of starting air bottles charged with air at 1000 lb. per square inch. The

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starting of one of the units ordinarily causes a drop of about 150 lb. in the pressure in one of the banks, and this is immediately pumped up again and the banks shut off; so that at all times there is available, for starting purposes, 35 cu. ft. of air at 1000 lb. gage pressure. This amount of air under pressure gives a large margin of security against accidental losses and possible disablement of the plant.

No trouble whatever has resulted in the handling of this high pressure air nor in its permanent storage at these pressures. The air piping is all of seamless drawn steel and heavy copper and all valves and fittings are equipped with lead sealed joints which can be tightened if necessary without disturbing the fittings. No appreciable leakage has so far been observed.

Two of the four cylinders of each engine are equipped with air-starting valves as shown at *b* in the sectional view, Fig. 4. These starting valves are entirely out of action in normal operation, but at starting they are thrown into gear by means of the handle *c*, which by the same movement throws the fuel valves out of gear.

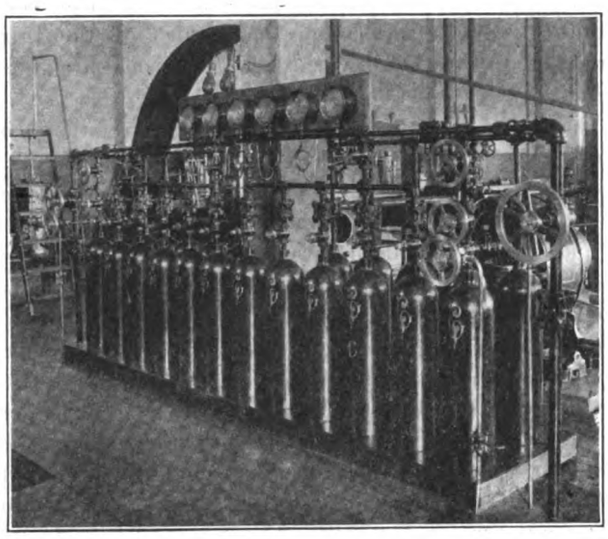

FIG. 10. AIR STORAGE BOTTLES.

With these starting valves in gear the engine acts, as far as that cylinder is concerned, as a compressed air motor, taking air at approximately 1000 lb. pressure from one of the banks of air-storage bottles, when it is turned on.

A few revolutions under the action of these two starting cylinders working on air, suffice to impart the necessary speed to the engine to enable the two remaining cylinders operating on fuel to start their normal operation and pick up the load. The starting valves are then thrown out of gear and the fuel valves in gear on the two starting cylinders and the four cylinders then operate normally on fuel.

The load is reduced at starting by opening by-pass valves on the ammonia compressors, and with this light load the engines gather the requisite speed for normal operation very quickly.

The lubrication of the engine pistons, wrist pins, and crank pins is taken care of by small pumps driven by links from each connecting rod, the pumps taking their supply from sight feed drips. The cylinder lubricant is forced through small holes suitably spaced around the cylinder walls. The main bearings are lubricated by ring oilers.

The consumption of lubricating oil is a point which is frequently referred to in connection with Diesel engines, and it is frequently compared with the cost of fuel. In some cases it undoubtedly does constitute a very material source of operating expense; but in many cases its relative importance is more due to the very low cost of fuel than to the high cost of lubrication. With certain designs of Diesel engines the consumption of lubricating oil can be kept at very low figures, while other designs show very high consumption; the influence of certain features of design being very pronounced. The subject is too extensive to go into further on general lines at present.

In the plant under description there is no means of definitely ascertaining at present just what the lubricating oil consumption does amount to, as there is now in use a very considerable quantity of oil which is being filtered and used and refiltered and re-used without any present need of replenishment. This condition has substantially existed for several months and it is impossible to state how much time will elapse before this oil becomes 'worn out' or filled with matter which will not filter out. The main source of contamination lies in the drip from around the pistons, which at times may carry small quantities of fuel oil which escape combustion and work past the pistons, or some derivative therefrom. Relative to the amount of fuel burned, such products are in an ordinary sense negligible, but their effect on the lubricating oil is cumulative, and this action in the course of a certain time may be expected to render the lubricating oil unsuitable for further filtering and use, and its replacement by fresh unused oil necessary. When this will occur in this plant is problematical and it can only reasonably be expected that a year's operation will be required to render available any accurate data regarding lubricating oil consumption. What indications there are point to a moderate consumption.

The oil drains by gravity from the engine crank pits to receivers in the basement, from which it is drawn and filtered in Richardson-Phoenix filters and re-used.

Aside from the cylinders there is no point of lubrication on a properly designed Diesel engine from which the oil cannot be entirely recovered and filtered and re-used for very extended periods.

The water jackets of engines and compressors are supplied by a continual circulation of the same fresh water; thus minimizing the chance of scaling. The water passes from the engine to a cooling coil in the basement, where it is cooled either by salt water flowing from the open ammonia condensers on the roof of the building, or by salt water direct from the bay, or by both together, according to the temperature requirements. The cooled jacket water from the coil is pumped to an overhead

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tank, from which it runs by gravity to the engine jackets. Provision is made for automatic connection with the city water mains by a float valve, should the circulating pump fail, or be shut down, or should loss of water from the system from any cause occur. The system is therefore well insured against possible failure and requires little attention.

Under present conditions of operation the water is supplied to the jackets at about 80°F. and issues from them at from 120° to 130°F., although at times much higher temperatures have been used.

The plant herein described since the period of adjustment and running-in ended, has operated with remarkable smoothness. None of the engineers employed had had any previous extensive experience in the operation of Diesel engines, but there has been no indication of any lack of their ability to handle any situation which may arise in connection with the operation and care of the engine; which is probably more than could be said under parallel conditions with a high-class steam plant. The plant was started about the middle of August 1914 and has been in uninterrupted daily operation since for 24 hours per day, one engine, from lack of present power requirements, usually standing idle. There has been no organized effort to make any lo ngnon-stop runs, but conditions of operation, which require 24 hours service, have made it convenient to keep one engine running continuously without a single stop for 15 days.

This run was made with the No. 2 engine, which was started on November 15 and shut down on December 1.

The engines have been put through carefully conducted tests and have met the makers' guarantees of fuel consumption based on the brake horse-power developed. As the engines were installed belted to both an ammonia compressor and electric generator, it was not possible to determine directly their brake horse-power. The tests were therefore carried out by determining from indicator diagrams taken at frequent intervals, the indicated horse-power, and deriving the brake horse-power from the indicated horse-power on the basis of certain accepted mechanical efficiencies.

These mechanical efficiencies, represented by curves which covered all conditions of loading from half load to 10% overload, were based upon the performances of a number of Diesel engines of similar design and size, and were accepted by both engine makers and purchaser previous to the tests. They assumed a mechanical efficiency of 76% at full rated load.

The following particulars are taken from the results of a test conducted by the writer, which was made under full load and covered a period of six hours; during which time, indicator diagrams were taken at intervals of not exceeding four minutes.

Revolutions per minute	250
Total indicated horse-power (mean)	259.52
Mechanical efficiency assumed, per cent	75.73
Total brake horse-power, (mean)	196.75
Total indicated horse-power, hours	1557.12
Total brake horse-power, hours	1,180.50
Total fuel consumed (6 hours), lb	485.75
Heat value of fuel, per pound, B.t.u	19,649
Fuel consumption per indicated horse-power hour, lb	0.3119
Fuel consumption per brake horse-power hour, lb	0.4114
Heat units supplied per indicated horse-power hour	6,129
Heat units supplied per brake horse-power hour	8085
Thermal efficiency on basis of indicated horse-power, per cent	41.50
Thermal efficiency on basis of brake horse-power, per cent	31.48

With the present adjustment of the period of fuel injection, these engines show a somewhat higher thermal efficiency at three-quarter load than they do at full load, and in ordinary every-day operation have shown that their consumption of fuel does not materially exceed the test results above reported.

Records of fuel consumption extending over a considerable period in connection with an approximated daily output of power indicate a normal fuel consumption in regular service of not exceeding 0.42 lb. of oil per brake horse-power per hour.

If we assume the price of the special fuel oil used at 95c. per barrel of 319 lb. then the cost for fuel per brake horse-power becomes 0.125c., corresponding to 8 brake horse-power for 1c.; which figure may, we think, be accepted as a safe allowance for the fuel cost of Diesel engine power under present conditions in the vicinity of San Francisco.

The maintenance of an efficiency in regular service approximating the best test results, is one of the very favorable characteristics of the Diesel plant, and is a feature in which it radically differs from the steam plant.

DETERMINATION OF THE MAXIMUM STORM WATER FLOW

By C. E. GRUNSKY

[The following data supplements that published on the same subject in our December issue, and should be added to it in order to make the discussion complete.—EDITOR.]

The rain intensity of 0.50 in. per hour for 2 hours indicates a value of $C = 5.5$.

The rain intensity of 0.33 in. per hour for 6 hours indicates a value of $C = 6.2$.

It will in this case be proper to assume $C = 6.5$, provided that the rainfall records cover a considerable number of years. Otherwise a somewhat higher value should be adopted to cover the contingency that the two storms were not in fact representative of extreme conditions.

For $C = 6.5$ by formula (2) it is found that $R = 0.84$.

By (7) $A = \dfrac{0.90 \times 500 + 0.75 \times 1200 + 0.40 \times 800}{2500} = 0.66.$

And by (6) $t = 0.40 \dfrac{85}{0.66 \times 2500} \times$

$(0.90 \times 500 + 2 \times 0.75 \times 1200 + 3 \times 0.40 \times 800) + 10.$

$t = 76$ minutes.

By (1) $I = \dfrac{6.5}{\sqrt{76}} = 0.74.$

Consequently by (9) $g = 0.645 \times 0.66 \times 0.74 = 0.32$ cu. ft. per second per acre, and the total maximum storm water flow to be expected from the 2500 acres.

$Q = 0.32 \times 2500 = 800$ second-feet.

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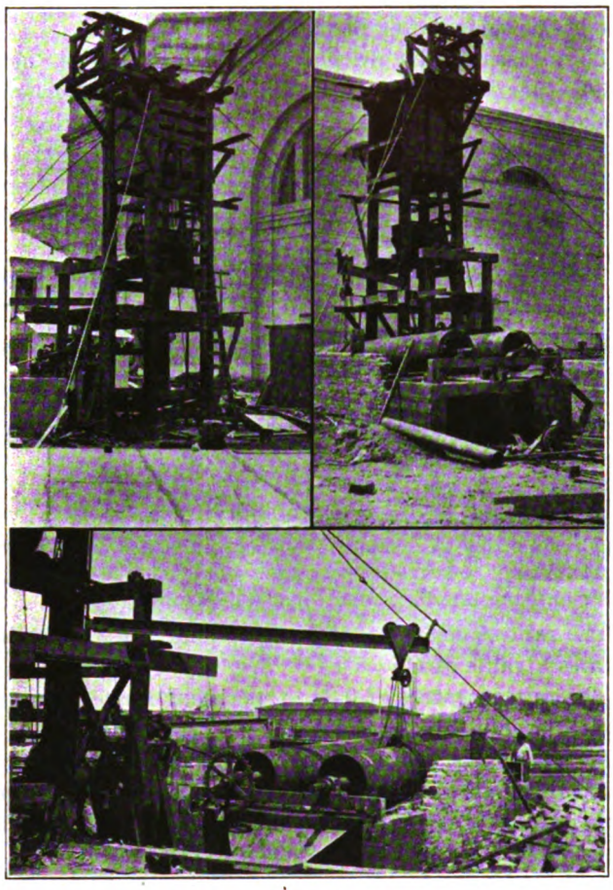
Asphalt Paving in the Grounds of the Panama-Pacific Exposition

By O. DIX JOHNS*

Owing to the general impression that the directors of the Panama-Pacific Exposition are improving the main thoroughfares by a system of water-bound macadam with no further treatment, this article serves as a means of correction and also an explanation of the actual type and method of construction in use.

In May 1914 the directors of the Exposition requested bids for the construction of 1,500,000 sq. ft. of surfacing, to be laid on the present areas covered by macadam. The specifications called for a unit price per square foot on two items, oil macadam 2 in. thick and asphalt wearing surface 1½ in. thick, to be laid upon this foundation of macadam when properly reshaped and brought to a uniform section by the grading forces of the Exposition company.



VIEWS OF MIXER DURING CONSTRUCTION.

After some deliberation regarding the relative merits of the two methods, asphalt surfacing was favored and the Company awarded the contract to the Raisch Improvement Co. of San Francisco. The privilege of erecting a plant within the grounds was accorded the Company, and August 3, after seven weeks' preparation, witnessed the production of the first paving mixture.

The design of the plant and its construction under the supervision of the author show some innovations of interest in plant building, and have proved successful. The main point considered was its erection at low cost, together with a capacity for rapid production; this latter was obtained by increasing the speeds of all moving parts. The next point was to secure a plant of such character that the cost of demolition would be minimized when the work was completed and permit its moving and erection on future work in the city or state.

Owing to the brief time allowed before commencing operation, the Company decided to install sand dryers of a permanent type furnished by the Geiger Iron Works of Stockton, California, on short notice. Awaiting delivery from Eastern manufacturers of a typical portable dryer consumed more time than could possibly be spared, so the idea of portability was carried out upon the mixing tower, leaving the question of portable dryers to some future work.

The tower posts are 10 by 10-in. pine, surfaced, 28 ft. long, 6-ft. centres, resting in cast iron shoes, and supported on concrete footings, 3 by 3 ft. by 1½ ft. deep, with anchor bolts for shoes imbedded. All horizontal and vertical bracing consisted of 3 by 10-in. surfaced lumber, bolted inside and out without scarfs or daps.

The mixer, 9 cu. ft. capacity, is anchored permanently on 10 by 10-in. sills and connected with a steam cylinder for opening and closing the discharge. The sand bin, capacity 12 tons, made of ⅜-in. riveted iron, is fastened by lag screws to the main tower posts and form a web for the upper portion of the tower. Mounted above the bin is a 24-in. circular screen, No. 10 mesh. From the upper points of the tower are four 1-in. rods with turnbuckles that lead to deadmen at the ground surface. Absolute rigidity is maintained on the mixer floor by this method.

Two-tower cast footings are designed similar to end posts on bridge spans, with casting and steel pin 3 in. diameter. In wrecking the plant for shipment, the anchor bolts on the two remaining footings are cast away, and the tower, in one section with bin, mixer, etc., is lowered to trucks supported by these pins and run onto a flat car.

On the line of the mixer floor is mounted a jib crane, 18 ft. long, with a crawl from which is slung a duplex block of 3 tons capacity. The work of setting and removing the heavy dryers and kettles is greatly facilitated. The tower acting as a mast is then removed.

Asphalt for the work is delivered in tank-cars of 38-ton capacity by the Standard Oil Company of Cali-

*Raisch Improvement Co., 1187 Washington St., San Francisco.

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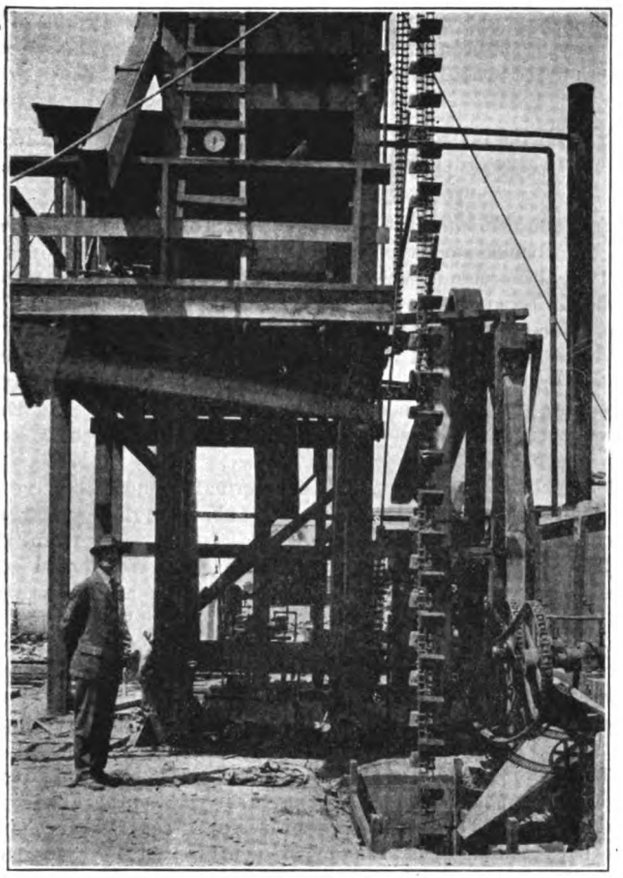
fornia, and brought into the ferry slips, switched into the yards, and unloaded after 12 hours of steam heating to a temperature of 230°F., into a wooden storage tank of 20,000-gal. capacity. The tank is 10 by 60 by 4½ ft. deep, imbedded 3½ ft. in cinders and clay,



LOWER PORTION OF MIXING TOWER.

and built up of 2 by 6-in. ribs and 1 by 12-in. tongue-and-groove pine, surfaced, free from knots, but not seasoned. Joints are driven tight and filled with cotton wicking. In order to take care of the contraction of the wood and consequent opening of the joints, armature varnish was brushed over these and 1½ in. each side, over which an unbleached muslin strip 3 in. wide was placed, followed by an application of the varnish, which held the strip rigidly in place and bound it to the fibre of the wood, thus making an absolutely tight joint and one which has given no trouble at all since the plant was started.

A 2-in. steam coil system, 1600 ft. long and running in 9 parallel rows, three pipes deep, with the lowest coil 5 in. from the tank bottom, was installed. There was a steam inlet at one end and an outlet into a steam trap at the other, from which the condensation was led back into the boiler. The temperature maintained in the tank is 230°F. At this temperature a rotary pump, with a 2½-in. suction and 2-in. discharge, pumps, at 140 r.p.m., through 30 ft. of pipe with a 9-ft. suction into the service tanks at the foot of the tower. From these another rotary pump lifts to the mixer floor.

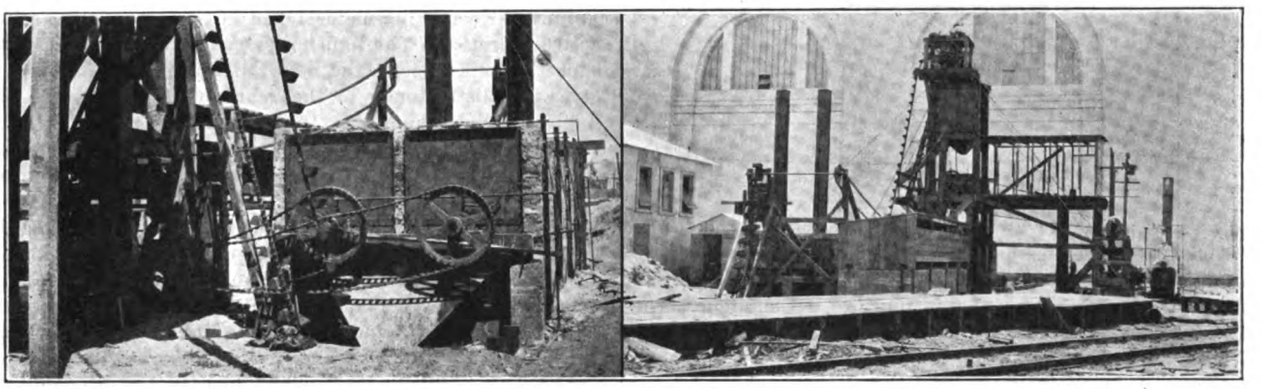
The dryers consist of two 30-in. steel tubes 18 ft. long with interior anchor plates riveted to the shell to promote the separation and transference of the sand which is fed by bucket hoist. Hot gases from two oil burners pass under the tubes and return through them and thence into the stock.

Fuel oil for the boiler, service tanks, and dryers is stored and pumped by steam from a wooden storage tank, 8 by 30 ft. by 4 ft. deep, of a similar construction to the asphalt storage tank. To date, no leakage in either tank has been detected.

Mounted on an elevated wooden platform 8 ft. high is a 40-hp. motor used for the main drive. On two sides of the tower at the mixer floor level is a 3½-ft. platform with guard and hand-rail supported from the main tower posts. This affords ample room for the operators.

Over the driveway, supported at one end by the main tower and the other end by 6 by 6-in. posts, is the lime dust platform, with sufficient storage for a day's work.

On August 3 the plant was placed in operation, and except for the first three days, when short delays were experienced from slipping belts and machine adjustments, it has run steadily for 45 days. The average daily run for this period is 23,000 sq. ft. Recently, owing to some changes of a permanent character, the delivery has been increased to 27,000 sq. ft. Operations on the street are conducted in the usual manner, with the exception of hot hand rolling, which it was decided might be omitted.



VIEWS OF MIXER AS INSTALLED.

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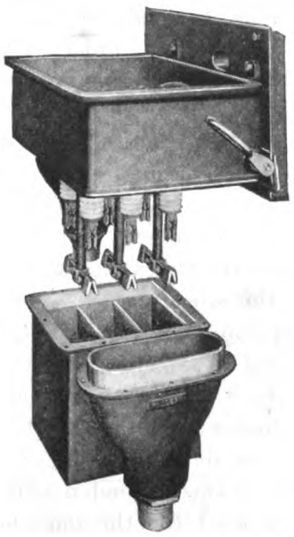
Industrial Progress

OIL SWITCHES FOR MANHOLE SERVICE

Two new types of manhole oil switches for mounting on flat vertical surfaces have recently been developed by the General Electric Co. One of the switches is for operating by hand and the other by a solenoid, which is an integral part of the switch. They can be used in places where there is danger of flooding.

In the hand operated switch, there are two bell chambers



OIL SWITCH WITH SPECIAL BELL CHAMBER FOR ENTRANCE LEADS.

through which run the loads to and from the switch. This chamber is of the usual construction and, after the leads are connected to the switch terminals, is filled with an insulating compound and made air-tight. The bell chambers as well as

SOLENOID OPERATED OIL SWITCH.

the oil vessel and cover are cast iron. They are bolted to the cast iron switch frame, the joints being made water-tight by gaskets. The operating handle is outside the frame and can be operated by a hook from the entrance to the manhole. The shaft handle passes through a stuffing box.

The solenoid operated switch is as a rule operated from the central station by the usual control switch situated in the station. The mechanism is especially simple, the plunger of the solenoid being connected direct to the cross-head attached to the operating rods. The switch solenoid uses current only while the switch is in the act of closing or opening by means of the tripping coil. The switch is held closed by a catch, which allows the switch to open by gravity when the catch is thrown out of position either by the trip coil plunger or by a small tripping level situated outside the switch frame.

Both hand and solenoid operated switches have an indicator which can be seen from the top of the manhole and shows whether the switch is open or closed.

UNIVERSAL CEMENT EXHIBIT AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

Portland cement made from blast-furnace slag is to be shown in its various stages of manufacture in the exhibit of the Universal Portland Cement Co. at the Panama-Pacific International Exposition. The exhibit has now been installed in the Palace of Mines and Metallurgy. Its completion so far in advance of the actual opening is typical of what the builders of the Exposition have constantly maintained, namely, that a new note in exposition management has been struck and that when opening day arrives February 20, 1915, everything will have been made ready and in its place.

The exhibit is one of the most instructive and attractive to be found at an exposition that has demanded that exhibitors produce something of a constructive nature aside from the ordinary display features. The growth of the reinforced concrete industry in the past few years has brought the making of cement into great prominence. Through the conversion of slag, hitherto a waste product, into a valuable building material, a step has been taken toward elimination of waste in manufacturing. The Universal company is a subsidiary of the United States Steel Corporation, one of the largest single exhibitors at the Exposition.

The exhibit, while occupying part of the parent company's section, is distinct in itself, and is in the southern part of the building. The design shows a series of concrete arches in the background. The front of the central part of the section is built to resemble the entrance to a factory, all in concrete. Floral decorations are arranged in concrete receptacles above the arches. Cement posts with tubular railings and velour drapings mark the boundaries. The exhibit is intended to show the uses of cement on the farm, in the erection of factories, residences and bridges, and in the laying of streets, roads, and walks. In the archways on either side of the central part of the exhibit are paintings illustrating the uses to which cement may be put.

On entering the visitor finds a large-sized replica of the Company's factory near Pittsburgh, Pennsylvania. A mechanical contrivance called a scenograph, electrically operated, is employed. Trains of cars are seen moving back and forth in the foreground, slag cars are run out of the dumps, and a large traveling bridge crane is seen in action in the background. Everything is designed to give the appearance of active operation. The lighting is well arranged. Daytime and sunset effects appear and with the scenic background used, give a realistic touch to the representation. As the sunset lights gradually appear in the sky, the interiors of the buildings are illuminated and the rolling mills are seen in operation.

In another section a large case shows Universal cement in various stages of manufacture. The quarrying of the limestone is first shown, and then the limestone after being crushed. The granulated slag is then mixed with the limestone in tube-mills. This mixture is calcined in rotary kilns at a temperature of 2500 to 2800°F., from which it goes to the clinker storage pits and then to the finishing mills, where are the automatic samplers and testing laboratories, and where the sacks are filled and loaded into cars for shipment. Samples of the cement as it appears in the different processes of

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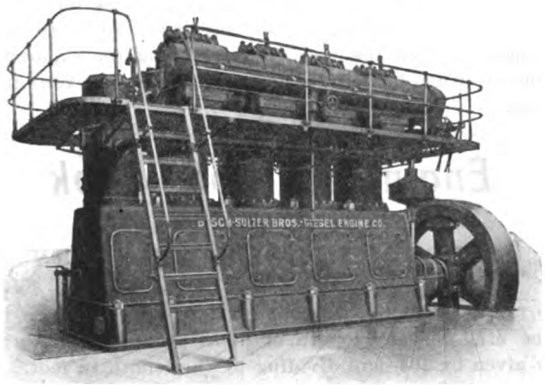
manufacture are shown. Other features of interest in the exhibit are a reinforced concrete silo as it is built for use on the farm; a 7-story building of fire-proof construction showing a concrete fire-escape; and a relief map of the United States showing the situation of the Company's plants and distributing stations. The furniture used in the exhibit is all constructed of steel.

The exhibit has been installed by J. A. Race of the Universal company under the supervision of Harry V. Jamison, director of exhibits for the United States Steel Corporation at the Panama-Pacific International Exposition.

A NEW DIESEL ENGINE INSTALLATION

A notable installation and one that will be watched with keen interest by engineers, is the new raw water ice plant for the Needles Ice Co., at Needles, California. This plant consists of two Busch-Sulzer Bros.-Diesel engines, a 500 b-hp. driving a 125-ton Ball ammonia compressor, and a 120 b-hp. engine direct connected to an alternating current generator



VIEW OF ENGINE.

which will be used to supply power for auxiliaries. This type of prime mover was selected after a thorough investigation and an extended tour throughout the United States to investigate the type and make of engine best suited to the needs of this Company.

The engines selected are of the four-cycle, four-cylinder type, enclosed crank case with air-compressor cast integral with the engine, means for effective cooling of the air between stages and after compression and for the extraction of water being provided. Force lubrication is accomplished by a rotary positive displacement pump. Water cooling is provided in the cylinders, cylinder heads, exhaust valves, compressor, exhaust piping, and pistons.

This plant itso be running before the early summer, 1915, and it is designed to be one of the most economical ice plants in California.

CORRUGATED CULVERT DECISION

A decision of considerable importance to makers and users of corrugated culverts has recently been rendered. In the case of the Economy Culvert Co. *v.* Frank McPherson, Highway Commissioner for the town of Ithaca, New York, the United States Court of Appeals for the Second Circuit, having final jurisdiction, has just handed down a mandate reversing the lower court and holding the Watson corrugated culvert patent valid and infringed by the culvert installed by the defendant.

In brief, the Court holds: "The claim is for a sheet metal culvert composed of connected cylindrical sections having circumferential corrugations extending to the extremities of the sections. Each section terminates at one end in a flared and at the other end in a contracted portion of a corrugation, so that two sections may interlock, the ends being held in place by bolts or similar means. The corrugations greatly strengthen the culvert and the doubling of the corrugations at the joints braces and adds stability in the structure. The fact that Watson, during the early years of his patent, was almost invariably repulsed by those interested in the art because they thought his device empirical, inefficient, and perishable, is persuasive to the conclusion that his improvement was not obvious. In view of the phenomenal success of the patented pipe after the public became aware of its advantages and the strength and durability which it has developed after years of trial, we are of the opinion that any doubt as to patentability should be received in favor of the patent.

"Infringement is clearly shown, the two structures are almost identical and the only differences are of form and not of substance. The defendant passes the rivets through the metal at a point farther from the ends of the section by less than an inch than in the complainant's structure. The difference is trivial and nothing functional is accomplished thereby. The decree is reversed with costs, and the cause is remanded to the District Court with instructions to enter a decree for the complainant in the usual form."

Hints on Practice

CONCRETE CHIMNEYS

Fire statistics show that defective flues are the cause of a great majority of the fires that occur in dwellings. So far

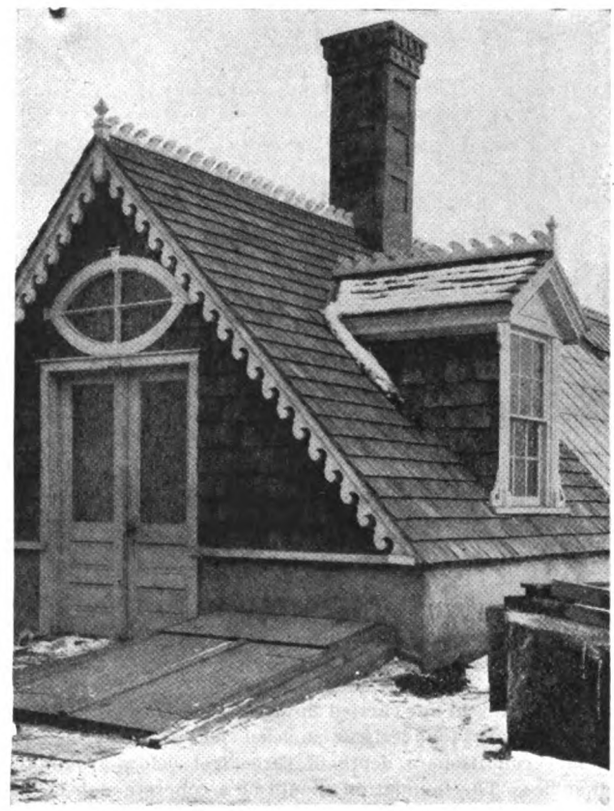


FIG. 1. ORNAMENTAL DESIGN FOR TOP OF CHIMNEY.

as safety from fire is concerned, the chimney is the most important structural feature of a building. A properly constructed chimney should be a seamless monolith, and in recog-

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nition of this fact, many builders are now using concrete. Concrete chimneys have no joints, and sparks or burning soot cannot come in contact with surrounding woodwork. They can be constructed in two ways. Either outer and inner wooden forms, betwee which the concrete is poured, can be used, or the inner form may consist of a clay or concrete tile, either round or square in section. Where the tiles may be procured easily, it is simpler to use them for the inner form. All chimneys, regardless of size, should have good foundations.

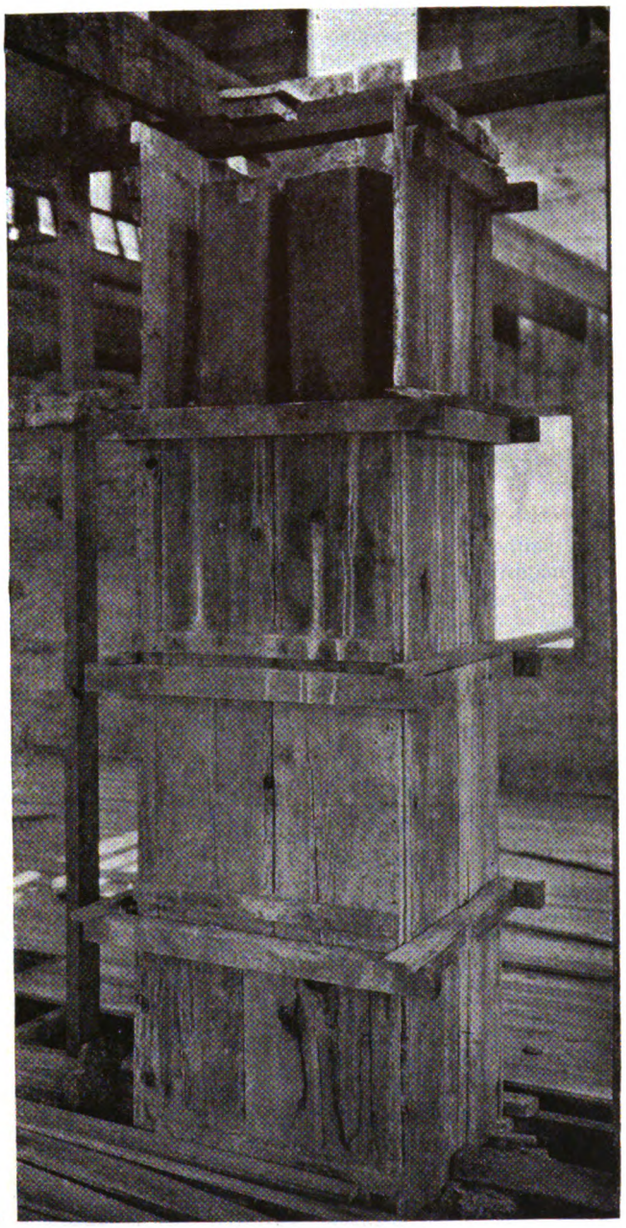

FIG. 2. FORMS FOR CHIMNEY.

If the chimney is not carried down to the depth of the cellar, it should have foundations at least below frost line. For ordinary conditions a depth of three feet below ground-level will suffice. The foundation should be a concrete slab 12 or 18 in. thick and 9 in. larger on every side than the outside dimensions of the chimney. Where the house is constructed with concrete walls, the chimney is cast with the walls, and needs no separate foundation.

The necessary forms are simple and easily made. Fig. 2 illustrates the method of constructing forms and the manner in which they are held together. In this illustration will be seen the two flues which constitute the inner form. To make the depositing of the concrete and the placing of flues an easy matter, forms are built up as the work progresses. Where the chimney is hidden by interior plaster and the walls of the building, only rough forms are required, such as are shown in Fig. 2. When the roof level is reached, more attention should be given to the forms in order to secure a smooth and even surface. The boards should form tight joints; each section of form should be properly aligned. If desired the chimney can be relieved with a simple ornamental design, such as is shown in Fig. 1. In providing for this it should be remembered that the ornamentation must be placed on the inside of the outer form and that the design will be reversed on the surface of the chimney.

A 1:2:4 mixture of concrete should be used. A bottomless measuring box of 2 cu. ft. capacity is convenient in measuring the materials. The concrete is mixed mushy wet and well tamped and spaded into the forms. While not absolutely necessary for small chimneys, it is a wise precaution to embed vertical ⅜-in. or ½-in. steel rods in each corner of the chimney. It is often the custom to wrap the tile flue forms in one or two thicknesses of tar or building paper so as to leave a small space around the flues, thus allowing for expansion of the concrete when heated, the purpose being to prevent it from cracking.

Engineers' Note Book

TABLES OF ELECTRICAL CAPACITY

The tables, from the *General Electric Review*, given below, may be used for any length of main by multiplying the capacity given by 100, and dividing by the length in feet. Thus, suppose a 500-ft. No. 00 secondary at 224 volts delivered with a voltage loss of 1%, a power factor of 80%, and with the load concentrated at the opposite end from the transformer, is carrying a load of 11.8 kw. and it is desired to know the voltage drop. From Table I, a load of 11.8 kw. will produce a drop of 1% in a line 100 ft. long. For a line 500 ft. long, 2.36 kw. will produce a drop of 1% in the voltage. A drop of 11.8/2.36 will be produced by the given number of kilowatts, or 5%. The actual voltage drop is then 5% of 224 or 11.2 volts.

KILOWATT CAPACITY OF SECONDARY MAINS

TABLE I

Load concentrated at opposite end of main from transformer.
Single-phase; 1% maximum volts loss; 224 volts delivered.
Upper figures—95% P.F. (lights).
Lower figures—80% P.F. (motors).

Wire size, B. & S.	Power loss, %.	Capacity, kw. Maximum.	Capacity, kw. For 100 ft.
6	0.95	14.9	5.2
	1.00	12.5	3.9
4	0.90	19.1	7.8
	0.91	16.1	5.6
2	0.85	26.6	11.8
	0.79	22.4	7.8
0	0.76	42.6	16.8
	0.67	35.9	10.5
00	0.74	48.0	20.5
	0.60	40.3	11.8
000	0.67	58.6	23.4
	0.51	49.3	12.7
0000	0.62	69.2	27.4
	0.48	59.3	15.0

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TABLE II

Load concentrated at opposite end of main from transformer.
Single-phase; 1% power loss; 224 volts delivered.
Upper figures—95% P.F. (lights).
Lower figures—80% P.F. (motors).

Wire size, B. & S.	Power loss, %.	Capacity, kw. Maximum.	Capacity, kw. For 100 ft.
6	1.00	14.9	5.5
	1.00	12.5	3.9
4	1.00	19.1	8.7
	1.00	16.1	6.1
2	1.00	26.6	13.9
	1.00	22.4	9.9
0	1.00	42.6	22.0
	1.00	35.9	15.7
00	1.00	48.0	27.7
	1.00	40.3	19.7
000	1.00	58.6	35.0
	1.00	49.3	24.8
0000	1.00	69.2	44.2
	1.00	59.3	31.4

TABLE III

Uniformly distributed load, transformer at one end.
Single-phase; 1% maximum volts loss; 224 volts delivered.
Upper figures—95% P.F. (lights).
Lower figures—80% P.F. (motors).

Wire size, B. & S.	Power loss, %.	Capacity, kw. Maximum.	Capacity, kw. For 100 ft.
6	0.95	14.9	10.4
	1.00	12.5	7.8
4	0.90	19.1	15.6
	0.91	16.1	11.2
2	0.85	26.6	23.6
	0.79	22.4	15.6
0	0.76	42.6	33.6
	0.67	35.9	21.0
00	0.74	48.0	41.0
	0.60	40.3	23.6
000	0.67	58.6	46.8
	0.51	49.3	25.4
0000	0.62	69.2	54.8
	0.48	59.3	30.0

Book Reviews

HANDBOOK OF CONSTRUCTION PLANT. By Richard T. Dana. Myron C. Clark Publishing Co., Chicago. P. 688. Index. For sale by the *Mining Press*, San Francisco. Price $5.

Probably the most important feature of this book is an abstract of almost every trade catalogue in existence. The net prices of all forms of construction equipment, from air-compressors through steam-shovels and photographic equipment down to wheelbarrows, are given. On the other hand, such commodities as coal, lumber, provisions, etc., are very properly omitted. The prices given, as far as the reviewer has been able to judge, are reliable, after allowing for variations due to time and place of purchase. There are a number of tables of capacities taken mainly from the manufacturers' catalogues. In addition, there are, under the various headings, considerable operating cost data from actual performance of the apparatus listed. Some of this is taken from handbooks and periodicals, while there is much that is published for the first time. There is an appendix of names and addresses of manufacturers, indexed according to the commodity made. There is no table of contents, but the alphabetical arrangement of the data together with a complete index renders this unnecessary. Engineers and contractors will find this book of much value as a reference work and first aid for preliminary estimates.

EXAMINATION OF LUBRICATING OILS. By Thomas P. Stillman. Chemical Publishing Co., Easton, Pennsylvania. P. 120. Index. For sale by the *Mining Press*, San Francisco. Price $1.25.

Directions are given for making the various tests necessary in the examination of lubricating oils, together with descriptions of the apparatus used. In addition to the matter usually included in a treatise on oil analysis, there is a discussion on the analysis of cylinder deposits, and also a description of methods of testing the behavior of an oil when used in the presence of superheated steam.

THE REGULATION OF RIVERS. By J. L. Van Ornum. McGraw-Hill Book Co., Inc., New York. P. 379. Index. For sale by the *Mining Press*, San Francisco. Price $4.

The introduction and first chapter of this book contain a discussion of the commercial aspects of river improvement, together with a comparison of rail and water transportation, mainly with respect to cost. Then the general hydraulic phenomena of rivers, including run-off, erosion, and accretion, are considered, following which methods of river survey are summarized. A general discussion of methods of river improvement follows, after which the particulars of the various methods are taken up, including channel contraction, bank protection, dredging, and levees. The final chapter deals with control of the river current.

ELEMENTS OF FORESTRY. By F. F. Moon and N. C. Brown. John Wiley & Sons, New York. P. 388. Index. For sale by the *Mining Press*, San Francisco. Price $2.

Part I of this book is devoted to a general discussion of forestry, taking up first the natural conditions affecting the growth of trees, then the various systems of cutting timber for best results, artificial planting, and protection from fire and other enemies of forest growth. Forest mensuration, methods of lumbering, and the utilization of wood, also its technology and preservation, are discussed. The final chapters of this part consider the financial and economic aspects of forestry.

In Part II the forests of the United States are classified in several main divisions according to locality, and the general characteristics of each are briefly considered. The appendix contains a list of the principal American species and their general characteristics and properties, a summary of the various log rules and other estimating formulae, also some data regarding the average rate of growth of the various species. The treatment of the work is non-technical throughout. The book would be of value either as an elementary text-book or for the layman who wishes to acquire a general idea of the subject. While no definite section is devoted to the Federal Forest Service, considerable information regarding its work is incorporated.

Recent Publications

THE DIAPHRAGM METHOD FOR THE MEASUREMENT OF WATER IN OPEN CHANNELS OF UNIFORM CROSS-SECTION. By Carl Robert Weidner, C.E., University of Wisconsin. Engineering Experiment Station, Madison, Wisconsin. P. 72. Ill. Price 25c.

RELATIVE RESISTANCE OF VARIOUS CONIFERS TO INJECTION WITH CREOSOTE. By C. H. Teesdale. *Bulletin* No. 101, U. S. Department of Agriculture, Washington, D. C. P. 43. Illustrated.

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Construction News Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALTURAS—Railroad Commission has directed the Nevada-California-Oregon Railway to erect new depot.

ANAHEIM—Ornamental lighting system will be installed in the business district.

ANDERSON—H. H. Henderson, engineer for the Anderson-Cottonwood irrigation district, has reported to the board of directors that the proposed project will cost $350,000 and cover 32,000 acres Plans include tunnel at the point of diversion near Redding, and a canal to carry 17,600 miner's inches.

AUBURN—Plans are being considered for municipal lighting plant.

BAKERSFIELD—N. D. Phelps has been awarded contract for conveyor for county rock quarry at Keene at $2450.——Board of Supervisors will receive bids until 10 a.m., January 9, for road improvements in division 7, section 1. Work includes 9140 cu. yd. excavation, 62,110 lin. ft. shaping roadbed, 32,400 tons broken stone and screenings, 234.8 cu. yd. concrete, 3631 lb. reinforcing steel, 1054 ft. standard guard fence, and about 1600 ft. corrugated pile, various sizes.——Board of Supervisors will receive bids until 11 a.m., January 9, for road improvements on division 5, section 1. Work includes 1160 cu. yd. excavation, 2804 lin. ft. creosoted piling, 81,909 ft. B.M. creosoted lumber, 89.4 cu. yd. concrete, 1406 lb. reinforcing steel, 594 ft. standard guard fence, and about 1000 ft. corrugated pipe, various lengths. Plans and specifications from P. H. Everett, chief engineer Highway Commission.

BENICIA—J. J. Henry, representing the A. D. Bowen Co., is receiving bids for construction of part of proposed Benicia-Vallejo electric railroad

BLYTHE—Mercereau Bridge & Construction Co., Los Angeles, was awarded contract for constructing jetties, driving piles, excavating ditches, etc., at $23,740.——J. E. Ludy is considering plans for pumping plant and irrigation system for mesa lands in this vicinity.

BURLINGAME—Contract for paving streets in Langville district has been awarded to the Federal Construction Co, Sharon Bdg., San Francisco, for $33,950.

CHICO—James D. Phelan, San Francisco, is considering plans for pumping water from Sacramento river, to irrigate his own holdings and other land in this vicinity, about 15,000 acres in all. ——Chico Business Men's Association is promoting irrigation district for large acreage in Butte county.

COMPTON—C. W. Corbaley, H. W. Hellman Bdg., Los Angeles, has been awarded contract for constructing four timber bridges and three corrugated culverts for $4985.

DINUBA—Odd Fellows Hall Co. will erect building.

EAST SAN DIEGO—Contract for improving University avenue has been awarded to Morse Construction Co. at $7952.——George B. Keith will erect hotel costing $50,000.

ESCONDIDO—John M. Gardiner Co, Los Angeles, has been awarded contract for furnishing cast iron pipe for municipal water system at $55,000.——Contract for constructing reservoir for municipal water system has been assigned to J. M. Gardiner Co., Byrne Bdg., Los Angeles. The two contracts amount to about $60,000.

ETNA—Contract for constructing sewer system was awarded to E. D. Fritts, Vallejo, for $15,658.60.

EUREKA—John M. Devoy has been awarded contract for grading Murray street at $2644

FRESNO—Contract for reinforced concrete bridge over Kings river has been awarded to W. A. Kettlewith & Son, Sierra Madre, for $19,680. Contract for ten pile bridges has been awarded to W. F. Jones at $10 70 per foot.——Improvements to County Hospital costing $15,000 will be made.——Bowen & Davis have prepared plans for residence for I. Teilman, costing $12,000; flat for R. Cutten, costing $7500; bungalow for L. Smith, costing $5000.——E. Mathewson has completed plans for Washington grammar school. Cost $100,000 ——E. J. Kump has completed plans for open-air auditorium at Hughson.——F. A. Cleveland, Corcoran, will erect two-story brick building at E and Kern streets, costing $30,000. Plans are being prepared by J. C. Thayer, Fresno.——Contract for erecting Webster school has been awarded to James L Daly for $52,700; for erecting Longfellow school to Evans Contracting Co. for $85,250. ——Thompson Bros. have been awarded contract for improving Kern avenue at $3581.——Expenditure of $330,000 for permanent buildings for the Fresno Normal school was authorized by Advisory Board of the State Engineering Department.——Fresno Interurban Railroad Co. has been authorized by State Railroad Commission to issue $350,000 in bonds and $212,500 in common stock.——Plans for electroliers having a one-light standard have been accepted by council. B. E. Cronkhite, city engineer——J. P. Williams and M. R. DeViese have been awarded contract for McMullen Grade bridge for $3987. ——Contract for concrete sidewalks in Courthouse park has been awarded to C. P. Walton.

GLENDALE—P. L. Ferry has been awarded contract for improving Canada boulevard, at $2 per lin. ft. grading, 16c. per sq. ft gutter, 10c. sq. ft. macadam paving, 25c. ft. Class B curb, 10c. sq. ft. walk, 40c. ft. 6-in. and 8-in. tile drain.

HEBER—Imperial Valley Improvement Co. has been awarded contract for installation of electric lights on Main street.

HOLTVILLE—McLean & Walsh, 1706 Arlington street, Los Angeles, have been awarded contract for constructing the Vrooman Act portion of sewer system at $21,243 08.——Doyle Bros., 220 Juniper street, San Diego, have been awarded contract for constructing outfall sewer at $11,545.65.

HUNTINGTON BEACH—La Bolsa Tile Co. will install machinery for manufacture of roofing tile and bell pipe. Richard Lyons, Long Beach, general manager.

IMPERIAL BEACH—Plans for lighting district to extend from south of Palm station through South San Diego to Imperial Beach were adopted at a recent election.

LAKEPORT—Carnegie library, costing $8000, will be erected. L. J. Shuman is chairman of board of trustees

LINDSAY—Contract for new grammar school has been awarded to Benson & Johnson, Kingsburg, for $44,069.

LODI—City Engineer L. B. Barzellotti is preparing plans for storm sewer system——Clark & Henery Construction Co. has been awarded contract for paving West Elm street for four blocks.

LONG BEACH—W. H. Austin has completed plans for two-story brick armory building for Company H, N. G. C.——Fairchild-Gilmore-Wilton Co. have been awarded contract for grading and paving alley between Linden and Elm avenues at 15c. per sq. ft——Long Beach Racing Coaster Co. will erect $100,000 roller coaster.——Long Beach Improvement Co. has been awarded contract for four-story steel, hollow tile, and brick building at Pine and Ocean avenues for Markwell Bros., costing $150,000.——Los Angeles Dredging Co. has been awarded contract for dredging harbor entrance channel for about $30,000. ——J. H. Morey will erect three-story building costing $18,000.

LOS ANGELES—San Pedro, Los Angeles & Salt Lake Railroad has applied for a right-of-way through forest reserve from San Bernardino to Daggett.——Atlas Building Co., 905 Van Nuys Bdg., has been awarded contract for residence for J. H. Smailes at $10,000.——Charles H. Richmond, 105 Henne Bdg, has been awarded contract for frame residence in Hollywood for Mrs. V. Knudsen at $19,500.——J. J. Frauenfelder, Story Bdg., has completed plans for 11-story building for H. O. Thompson, costing $300,000.——Hunt & Burns, 701 Loughlin Bdg., are preparing plans for residence for Henry D. Lombard costing $50,000.——L. L. Jones, 1125 Central Bdg., is preparing plans for 4-story building to be erected at 7th and Gladys streets, costing $48,000.——Concrete Building & Investment Co., 913 South Figueroa street, is building concrete residence for W. L. Dodge, costing $35,000.——Gauger Construction Co. has been awarded contract for concrete foundation for South Park Christian Church at $5375.——Thomas Haverty Co, 517 Los Angeles street, South, has been awarded contract for plumbing, heating, refrigerating, and sprinkler system for department store building for J. W. Robinson Dry Goods Co. at $64,000.——Board of Public Works has awarded following contracts: For improvement of Vernon avenue by paving, cement curbs, sidewalks, granite block gutters, and concrete culverts, to Ford & Stout for $66,630.60. For improving Brandon street, first section to S. McCray for $168.25; second section to R. H McCray, Jr., for $3402.17. For alley improvements to Fairchild-Gilmore-Wilton Co. for $12,641.40. For sewer construction in Denker avenue to H. H. Kock & John Chutuk for $7466.50. Also to the same contractors, sewer work in 15th street for $1552.04. For sewer construction in Figueroa street to John Sutalo for $583.——Fairchild-Gilmore-Wilton Co. has been awarded contract for improving Ninth street, San Pedro, at $41,102.79; for improving Stanford avenue at $17,631.41; for improving alley near Seventh street at $1169.83.——Following sewer contracts have been awarded: To John Sutalo, Menlo avenue, at $1017; to A. J. Wuletich, Figueroa street, at $9990; and 41st drive, at $850; to H. H. Kock and John Chutuk, 51st street, at $1575.75; Fountain avenue at $1255.70; and Mariposa avenue at $1066.20; to P. S. Tomich and S. Zarubica, Lorraine avenue, at $1200; and Avenue 64, at $3500; to A. Jayich, Central avenue, at $1370.——City Engineer Homer Hamlin has reported that proposed Bunker Hill cut between First and Second streets will cost approximately $3,370,000; and assessment maps have been ordered.——J. C. Duncan has been awarded contract for sewer construction in Townsend street at $6625.——J. V. McNeil, 530 Wesley Roberts

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Bdg., has been awarded contract for store building for I. O. Levy, at $8400.——R. C. Ferguson, Pacific Electric Bdg., is preparing plans for house in South Pasadena for W. H. Warner. Cost $17,000.——Milwaukee Building Co., Wright & Callender Bdg., has been awarded contract for residence for E. F. Kline. Cost about $13,000.——A. M. Moore, 1659 Middleton place, has been awarded contract at $10,989 for erection of residence for Frank Upman.——Fred Hoffman, 111 E. 12th street, Long Beach, has been awarded contract for county road improvement in district No. 67, at $33,500.——Board of Public Works will spend $8860 in repairing Third Street tunnel.——J. C. Austin, 1124 Baker-Detwiler Bdg., is preparing plans for $80,000 school for Owensmouth Union High School district.——E. C. Thorne, Realty Board Bdg., is preparing plans for two-story factory building for Wise & Downie. Estimated cost $16,000.——L. B. Pemberton, 807 Auditorium Bdg., is preparing plans for new bank building for First Bank of Hermosa. Cost $15,000.——Lepper & Laisy, 1911 Seventh avenue, will build three-story building for R. E. Seiler. Cost about $18,000.——Milwaukee Building Co., 316 Wright & Callender Bdg., will build residence for S. M. Behrendt at cost of $17,500, and for C. C. Maxon at cost of $13,100.——Mercereau Bridge & Construction Co., Pacific Electric Bdg., has been awarded contract for timber flume across New river, Imperial valley Cost about $34,000.——George S. Benson & Son, 521 Stimson Bdg., have been awarded contract for improvement of Wilshire boulevard, at $4253.50.——Pacific Coast Beef & Provision Co., 1000 Lyons street, will erect 6-story reinforced concrete cold-storage plant costing $250,000. J. E. Maurer is local manager.——Contract for improving Fifth street has been awarded to John Balch at $44,774.37.——Contract for improving 23rd street has been awarded to George R. Curtis at $14,122.18.——Harbor Commission proposes building three-unit floating drydock at San Pedro. Cost about $500,000——Property owners on Hollywood boulevard between Cherokee and Orchard avenues, will install lighting system.——Board of Public Works has ordered improvement of Dalton avenue between Santa Barbara and Vernon avenues.——E. C. Thorne, Realty Board Bdg., is preparing plans for two-story building for Wise & Downie. Cost $16,000.——F. W. Whittier has been awarded contract for paving Childs avenue for $10,616.47, and for paving Marguerite street for $10,830.96.——Ford & Stout have been awarded contract for improving McClintock avenue for $13,345.54.——Wells, Fargo & Co. Express will erect building at Southern Pacific depot, costing $100,000—Fairchild-Gilmore-Wilton Co. has been awarded contract for improving Wilton place for $19,016.50.——Ford & Stout have been awarded contract for improving Lake street for $645 68; also for improving 11th street for $3557.99.——C. W. Shafer has been awarded contract for improving alley near Clarence street for $1493 89.——C. Sheerer, 512 Stimson Bdg., has been awarded contract for improving parts of Oleander and Almond streets in Glendale for about $19,000.——Bids will be received until 9 a.m., January 13, for furnishing parts for steam fire-engines. C. L. Wilde, city clerk.——Bids will be received by O. H. Ensign, chief electrical engineer, U. S. Reclamation Service, Federal Bdg., until 2 p.m., January 11, for furnishing direct pumping units for Outlook irrigation district, Yakima project, Washington——J. Cholovich has been awarded contract for sewer in Cursin avenue at $569.——A. Dalmatian has been awarded contract for sewer in 5th street (San Pedro) for $244.——Joe Chutuk has been awarded contract for sewer in Lexington avenue for $1322.90.——Lepper & Laisy, 1911 Seventh avenue, will erect two-story brick hotel for R. E. Seiler for $18,000.——California-Arizona Construction Co has been awarded contract for improving Dorchester avenue at $9653.35.

MARYSVILLE—Hallwood Irrigation Co. will repair laterals and extend system. R. W. McCormick, secretary.——City Engineer Meek is preparing estimate on park improvement at Ellis lake. Probable cost about $30,000.

MERCED—Board of Supervisors have awarded contract to W. K. Widemann for building concrete bridge on state highway at $1391; to L. F. Pate for building three other bridges at $1124, $221, and $279.

MODESTO—Building will be erected at 10th and J streets. G. H. Umbsen, 20 Montgomery street, San Francisco, is interested.——Pacific Coast Construction Co. has been awarded contract for construction of three bridges and a siphon on county roads.——Board of Supervisors will receive bids until January 12 for construction of culvert on Oakdale road.——Bridge will be constructed at Laurel street over lateral four. City, county, and irrigation district will share cost, about $2000.

NEWMAN—Carnegie library, costing $8000, will be erected.

OAKLAND—Peoples Water Co. will extend mains to Beulah Heights district.——O. J. Mead will erect 7-story building at 10th and Clay streets, costing $104,000. W. Wilde, 1725 Broadway, is architect.——Twelve-story office building will be erected at 14th and Franklin streets. District Attorney W. H. L. Hynes is interested.——City Architect, J. J. Donovan, has completed plans for new Clawson school. Structure will be of reinforced concrete and cost $165,000.——Trinity Lutheran Church will erect building costing $17,000.

OROVILLE—Contract for bridge across Dark canyon has been awarded to the Chico Construction Co. for $1449.

PASADENA—G. W. Koiner, manager of the municipal light plant, recommends additions to buildings costing $30,000.——Warner & McCune, Monrovia, have been awarded contract for reservoir for Los Flores Water Co. at $5558.——Robert Young, 601 El Centro avenue, South Pasadena, who has contract for reservoir on William Allen estate, contemplates subletting part of the work, which includes 37,500 sq. ft concrete lining reinforced with Clinton wire mesh, 60,000 ft. B.M. lumber in roof, 2000 ft. 2-in. pipe for posts, and 2700 cu. yd. excavation.——James M Montgomery, Alhambra, has been awarded contract for constructing oil macadam pavement on Glenarm street at $3554.——Residence costing $400,000 will be erected. L. D. Bayley, Hartford, Conn., is architect.

PORTERVILLE—Riverside Portland Cement Co. has purchased limestone lands in this vicinity and will erect plant.——Council is considering erection of city hall costing $25,000.——City Engineer Althouse is preparing plans for brick building for Third Street water station——Main Street bridge will be widened. Estimated cost $5000.——Porterville Northeastern railroad will build spur from Adobe to quarries of California Granite Company.

RED BLUFF—Walton Bros., will erect post-office building. Sub-contract for basement and foundation has been awarded to O'Connor Bros.

RICHMOND—Frank McIntyre has been awarded contract for sewer in Herman addition at $4532.26.——Plans have been prepared by city engineer for dredging of 4000 ft. of channel from San Pablo canal to Standard Oil refinery——C. Overaa, 235½ Ninth street, has been awarded contract for erection of Main Street school building. J. C. Hurley Co. has been awarded contract for heating apparatus for building.——Macdonald avenue subway will be paved, and covered sidewalks installed.——Florin Bros. will erect three-story building at 23rd street and Macdonald avenue, costing $18,000.——Hayes & Hopping will erect garage costing $12,000.——C. F. Van Damme, 5th and Channel streets, is promoting ferry to Point San Quentin. Plans for ferry slips near San Pablo quarries are being prepared.

SACRAMENTO—Joseph Lewis will erect building on 35th street between Madrone and Cypress avenues, costing $35,000.——Rice & Dutcher, Imperial, Cal., have been awarded contract for 11.7 miles concrete paving on state highway between Coyote Wells and Dixieland, for $72,173.80.——J. W. Calback, 1918 Broadway, San Diego, has been awarded contract for five miles of concrete paving on state highway between Alcatraz and Las Cruces, in Santa Barbara county, for $58,923.30.——State Conservation Commission will make survey of about 2,000,000 acres of public land along Colorado river with a view to its reclamation under the Carey Act.——R. A. Herold is preparing plans for residence for D. Wasserman, costing $25,000.——G. J. Pendergast will erect 3-story structure costing $40,000.——State Engineering Department is preparing plans for improving navigability of Sacramento river near Crouch landing and at Collins Eddy. Cost $24,000——Following bids were received by State Highway Commission: For work in Orange county, Division VII, Route 2, Section A, Callahan & Hedrick, El Centro, $45,343.80; M. A. Company, Inc., Los Angeles, $35,-830.80; Modern Construction Co., Inc., Los Angeles, $40,763; engineers' estimate, $35,888.86 For work in Siskiyou county, Division II, Route 3, Section C: Blanchard-Brown Co., 660 Market street, San Francisco, $128,316.20; Palmer & McBryde, 503 Market street, San Francisco, $154,265; James Fitzpatrick, Sacramento, $126,330.25; Berry, Mackie & Co., 320 Market street, San Francisco, $90,653.30; Smith & Brice, Eureka, $105,715; E. T. Johnson, Portland, $90,522.10; F. Rolandi, 550 Montgomery street, San Francisco, $116,000.70; engineer's estimate, $120,-522.88 For work in Sutter county, Division III, Route 3, Section A: Taylor & Berliner, Los Angeles, $49,790.80; Chico Construction Co., Chico, $49,582.40; P. L. Burr, 461 Market street, San Francisco, $53,455; Tieslau Bros., Underwood Bdg., San Francisco, $56,696.10; L. F. Gerdetz, Rialto Bdg., San Francisco, $59,461 10; C. H. & A. W. Gorrill, Rialto Bdg., San Francisco, $42,381.10; Bates, Borland & Ayer, Oakland Bank of Savings Bdg., Oakland, $51,887.40; Whitlock & Gorrill, Hearst Bdg., San Francisco, $48,916.50; E. T. Johnson, Portland, $54,471.50; Forest City Paving & Construction Co., San Francisco, $48,674.40; engineer's estimate, $57,988.06. For work in Los Angeles county, Division VII, Route 4, Section C (450-day limit): H. A. Taylor, Los Angeles, $391,821.50; F. A. Keasel, San Francisco, $342,500; Robert Sherer, Los Angeles, $321,483; Chadwick & Sykes, Inc., Crocker Bdg, San Francisco, $498,707.50; L. S. Atkinson, Los Angeles, $630,810; Lee Moor Construction Co., Los Angeles, $256,-

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246; A. C. McLean Construction Co., 320 Market street, $315,895; Twohy Bros., First National Bank Bdg., San Francisco, $300,-896.50; Mahoney Bros., Merchants National Bank Bdg., San Francisco, $308,565; Rothwell & McCray, Los Angeles, $520,506.-50; engineer's estimate, $373,767.25. For same work, 250-day limit: Twohy Bros., San Francisco, 304,071.50; W. A. Richtel, Alton, California, $553,011; Mahoney Bros., San Francisco, $314,-915; Daley & Co. and H. Pederson, Seattle, Washington, $367,597; Lee Moor Construction Co., Los Angeles, $268,946; Smith & Brice, Eureka, $405,389; A. C. McLean Construction Co., San Francisco, $328,595; engineer's estimate, $381,069.75. For same work, 150-day limit: Twohy Bros., San Francisco, $326,296.50; Palmer & McBryde, San Francisco, $485,372.50; Mahoney Bros., San Francisco, $333.965; Lee Moor Construction Co., Los Angeles, $281,646; A. C. McLean & Co., San Francisco, $343,155; Smith & Brice, Eureka, $414,914; engineer's estimate, $402,977.25.

SAN DIEGO—United States Cast Iron Pipe & Foundry Co., of San Francisco, has been awarded contract for furnishing and delivery of 6-in. and 4-in. cast iron water pipe at $27.30 per ton.——Plans for administration building at municipal pier, costing $23,500, have been approved.——Consolidated Realty Co. will erect garage building on B street between 7th and 8th. Building will be reinforced concrete and tile, and cost $35,000.——Board of Supervisors will receive bids until 2:30 p.m., January 6, for construction of about 2½ miles of road in second district. J. T. Butler, county clerk.——M. D. Goodbody has been awarded contract for grading Raynard way, State street, and Goldfinch street at $30,342.15; also for grading Robinson avenue and Curley street for $4977.—Los Angeles & San Diego Beach Railroad has been authorized by State Railroad Commission to issue bonds for $350,000 for electrification of line between San Diego and La Jolla.——Bonds for $4000 have been voted for new school in Foster district.

SAN FRANCISCO—State Harbor Commission has recommended construction of office for Wells, Fargo & Co. Express on waterfront near Ferry building. Cost $55,000. Also enlarging and reconstructing pier No. 24.——Union Iron Works has been awarded contract by Electric Boat Co. for construction of eight submarines. Cost approximately $4,000,000.——City Street Improvement Co. has been awarded contract for paving Junipero Serra boulevard between Monterey and St. Francis boulevard. Board of Public Works has adopted specifications for raising and widening Oakdale avenue between San Bruno avenue and Rankin street.——Proceedings have been begun for building sewer in Hudson avenue between Lane and Mendell streets (estimated cost $9650), and for sewer in Lane street between McKinnon and Newcomb avenues (estimated cost $2550).——Following streets will be curbed and paved: Folsom between Cortland and Jarboe; Geary between 38th and 40th avenues; and Kirkham between 12th and 13th avenues.——Harbor Commission has prepared plans for footbridge across East street at Ferry building; cost about $15,000.——Electroliers will be installed on Fourth street.——Munster & Bornholdt have been awarded contract for two-story brick building for M. C. and J. B. Kennedy for $16,100.——F. Rolandi, 550 Montgomery street, has been awarded contract for constructing California Street Municipal Railway for $101,308.81.——Concordia Club has awarded contract for addition to its building to Dyer Bros., 17th and Kansas streets, for $50,196.——Panama-Pacific Exposition Co. has awarded the following contracts: Constructing racetrack grandstand No. 1, except grading and paving, to Neal A. McLean Co., Chronicle Bdg., for $17,000; installing pipe-line system, to the Turner Co., 272 Natoma street, for $37,000; constructing entrances, to Strehlow, Freese & Petersen, Exposition Grounds, for $15,120; constructing Scott Street entrance to M. P. Mortensen, 3121 Broderick street, for $8186.——Blanchard, Brown & Co., 660 Market street, submitted the lowest bid for paving Sloat boulevard at $58,194.——The Federal Construction Co., Sharon Bdg., was lowest bidder for paving San Bruno avenue at $38,852.——Bay City Building Co. has been awarded contract for lattice enclosures for automobile exhibit at Exposition Grounds for $11,470.——Strehlow, Freese & Petersen have been awarded contract for Mississippi building at Exposition Grounds for $13,192.——San Francisco Bridge Co., Nevada Bank Bdg., has been awarded contract for completion of Pearl Harbor drydock, Hawaii, for $1,261,350.——Davis, Rogers & Co., Monadnock Bdg., has been awarded contract for boilers in Civic Center power plant for $11,850.——Willman, Lyman & Co., 341 Minna street, have been awarded contract for underground distributing system for $23,964.——Contract for grading and excavating for four 55,000-bbl. tanks at Shell refinery at Martinez has been awarded to O'Brien Bros. & Smith.——Contract for grading spur tracks at refinery has been awarded to Thomas R. Hanna, Martinez.——Valley Pipe Line Co. has awarded contract for pumps for line from Coalinga to Martinez to Columbia Steel Works, Pittsburgh.

SANTA ANA—Keene & Norton, 4405 Bernice avenue, Los Angeles, have been awarded contract for grading 5¼ miles of Riverside road for $16,133.57.——E. K. Benchley has been awarded contract for $3190 for constructing six concrete bridges on Riverside road.——Board of Supervisors will receive bids until 2 p.m., January 6, for improvement of Section 2, Anaheim-Olive road. W. B. Williams, county clerk.

SANTA BARBARA—Board of Supervisors will call election for voting $250,000 in bonds for bridges and $100,000 for county hospital.——Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco, have been engaged as road engineers.——Humphrey & Elliott have been awarded contract for gymnasium at high school at $3715.

SANTA MONICA—J. D. Kneen Contracting Co., Dudley Bdg., has been awarded contract for improving Colorado avenue at $28,827.26.——Buller & Bock have been awarded contract for improving Hill street at $4882.74.

SOUTH PASADENA—Contract for construction of ornamental lighting system on Fairoaks avenue and north side of Huntington drive has been awarded to W. A. McNally Co., of Pasadena, for $15,948.

STOCKTON—Council has ordered installation of arc lights in several parts of city.——Following streets will be paved with macadam surfaced with rodamite: Clay street from Center to Lincoln; and Commerce, Madison, Monroe, and Van Buren streets from South to Jackson.——Council has called for bids for fire hydrants on Park street.——City Council has ordered following streets improved: Willow, Vine, and Rose, between Yosemite and Edison, Stockton and Baker, and North and Rose.——A. B. Munson & Son were awarded contract for improving streets in southwest section of city for $24,326.

TERRA BELLA—Contract for bridge over Deer creek has been awarded to Joseph Lovelace; and for two other bridges over Deer creek to Parlier Construction Co., Tulare. Total cost $6500.

TULARE—City Council has called for bids for 17 blocks of paving, concrete base and bitulithic surfacing.

VACAVILLE—Bonds for $30,000 for street improvements have been voted.——George H. Sharpe has been awarded contract for constructing Carnegie library.

VISALIA—County bond issue of $1,500,000 for roads was defeated.——Board of Supervisors will open bids early in January for construction of road from Badger to Sand Creek road.

WOODLAND—H. A. Klyce, Sheldon Bdg., San Francisco, has been awarded contract for erecting concrete jail at $50,000.

OREGON

COQUILLE—Shelley & Ensele have been awarded contract for construction of bridge on Beech street at $1914.44.

DALLAS—Municipal lighting system will be constructed.

EUGENE—Contract for construction of armory building has been awarded to C. Van Patton, Salem, for $37,333. Contract for wiring to W. Kraemer, Portland, for $1190. For heating to Valley Heating & Plumbing Co., Eugene, at $3290; and to R. S. Welch, Eugene, at $1549.

MARSHFIELD—City Council will receive bids for following work: 14,000 cu. yd. excavation, 5000 lin. ft. concrete sewer, 500 piles, 50 to 60 ft. long, 20 manholes, and 40 12-in. connections to present sewers. D. L. Buckingham, City Engineer. Noble estate will erect reinforced concrete building 100 by 50 feet.

MEDFORD—Sound Construction Co., of Seattle, was low bidder for erection of public building. Bid from $95,881 to $97,007, according to materials.——Land owners of Rogue River valley will form irrigation district. D. Carpenter is interested.

OREGON CITY—Pacific Bridge Co. was lowest bidder on steel pipe for South Fork water system at $209,770.45. Oregon Engineering & Construction Co. was low bidder for lap weld pipe at $307,348, and for riveted steel pipe at $297,052.——Pacific Bridge Co. was low bidder for open reservoir at $34,225; and Boyajohn-Arnold Co. was low bidder for closed reservoir at $77,298.

PORTLAND—Hall Bros. Marine Railway & Shipbuilding Co., Winslow, Washington, has been awarded contract for repairing and docking light-vessel No. 67, for $25,849.——Contract for Shattuck school has been awarded to Boyajohn-Arnold Co. Plumbing contract has been awarded to Sturges & Sturges for $10,542.——Roadmaster Yeon has reported surfacing Columbia highway will cost approximately $1,000,000.——Woman's building costing $120,000 will be erected at Reed College. William T. Foster is president.——James S. Winters has been awarded contract for annex to Richmond school for $49,097.——Eugene Ruedy has been awarded the plumbing contract at $2175, and G. E. Weaverson, heating and ventilating contract at $4995.——Alaskan Plumbing Co. has been awarded contract for heating and ventilating on Shattuck school for $24,400.——W. A. Kramer & Co., 532 Chamber of Commerce building, have been awarded contract for installing steel pipe and surge tank near Preston, Idaho, for Utah Light & Power Co.; cost $40,000.——F.

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A. Naramore is preparing plans for Kennedy school; cost $40,000. ——C. A. Duke has been awarded the contract for three-story brick and reinforced concrete building for H. Meter at $35,000. Guthrie, McDougall & Co. have been awarded contract for plank roadway from Front street to municipal dock No. 1, for $5104. W. A. Kraner & Co. have been awarded contract for wiring for $875.——Great Southern Railroad has made surveys for extension from Friend to Juniper Flats, about 29 miles. J. L. Meier, vice-president and general manager.——Following bids were received for sewer in Tibbetts street from East 31st street to East 36th street. For cement pipe, Azar & Co., $2165.12; for vitrified pipe, Chas. Solomon, $2117.40; George Gordon, $2148.15; George Abraham, $2182.26; F. Callans, $1985.18; Oregon Contracting Co., $1907.82; John Keating, $2200.90.——M. Kreilsheimer and Charles E. Frey will erect two-story brick and concrete building at Broadway and Denny Way, costing $20,000. ——Following bids were received for paving in Ladd's addition: Oskar Huber, $15,458.98 for bithulithic redress and $18,171.67 for asphalt. Warren Construction Co., $17,438.03 for bithulithic redress and $18,599.06 for asphalt.——Contract for paving East 30th street, has been let to Oskar Huber for $17,000.——Willamette Iron & Steel Works has been awarded contract for construction of government dredge 'Monticello' at $27,830.——Shope Brick Co. will erect residence for J. P. Tamiesie. Cost $15,000. ——Following bids were received for grading and sidewalks on 62nd street: Arthur D. Kern, $5946.64; Bodman & Burge, $5873.75; M. Hanson, $6077.55; Miller & Bauer, $5903.42; Cochran-Nutting Co., $6110.60; Manning & Co., $6061.70. Also for grading and sidewalks on East 78th street: Manning & Co., $1854.40; Solomon & Hanna, $2035.05; Arthur D. Kearn, $1852.62; George Gundlach, $1835.84; O. M Patton, $1915.28; W. F. Ryan, $1974.90; Owen & Lange, $2053.70; Miller & Bauer, $1871.66; Cochran-Nutting Co., $1816.60; Bodman & Burge, $1802.64.

PRINEVILLE—Metolius, Prineville & Eastern Railway Co. has completed surveys for electric railway from Prineville to Metolius, about 32 miles. H. B. Scheel, Prineville, is president.

SALEM—Plans for brick addition to Chicago store are being prepared by F. W. Legg. Cost $12,000.——Bids will be received in January for riveted steel bridge across Willamette river, to have three spans 160 ft. long and one 300 ft., concrete piers, and cost about $210,000. H. L. Bowlby, state engineer.——F. S. Bramwell and A. Nibley, Portland, are considering plans for beet sugar factory to cost $650,000.

SEASIDE—Port Engineer Walsh of Astoria is making survey of waterway from Seaside to Columbia river. J. E. Oates is interested.

SILVERTON—City Council is considering plans for installation of electric lighting system.

ST. JOHNS—City Council contemplates purchasing water system and making extensions.

WASHINGTON

ABERDEEN—It is proposed to install 4,000,000-gal. steam turbine-driven centrifugal pump at city water works. E. A. Lindstrom, superintendent.

ANACORTES—Karmer & Duvall have been awarded contract for construction of Elks Club building for $14,474.

BELLINGHAM—Property owners between this city and Lake Whatcom are planning to build three miles of concrete roadway. Estimated cost $75,000.——Babb & Gould, Denny Bdg., Seattle, are preparing plans for residence for Mrs. C. H. Larabee, costing $150,000.——City will pave three miles of Lake street with asphalt or macadam. Cost about $75,000.

BENTON CITY—Pacific Tank & Pipe Co., Portland, Oregon, has been awarded contract for 3000 ft. wood-stave pipe for Sunnyside irrigation project at $7263.

BREMERTON—Contract for erection of two 50,000 bbl. oil tanks at Navy Yard has been awarded to the Pittsburgh & Des Moines Bridge Co., for $28,590.

DAVENPORT—Coughren & Woldon have been awarded contract for repairing grade of Bluestem-Columbia branch of Great Northern railroad.

HILLYARD—Spokane Bitu-Mass Paving Co., Spokane, has been awarded contract for paving Market street for $4200. Specifications call for a 4-in. concrete base.

KELSO—Bonds for $60,000 in Diking district No. 2 have been sold and bids for clearing right-of-way will be asked. J. Wallace, G. T. Hogg, and J. Hall are commissioners.

KEYPORT—Fleines & Dahl, 5646 47th avenue, S. W., Seattle, have been awarded contract for construction of wharf and wharf shed at naval torpedo station, at $6989.

KIRKLAND—Municipal water system, costing $12,000 will be constructed. Reitze, Storey & Duffy, Northern Bank Bdg., Seattle, are engineers.

MONTESANO—North West Electric & Water Works Co. will erect electric power plant.

NANAIMO—City Council has voted to pave Haliburton street with asphaltic concrete. Cost $39,000.

NORTH YAKIMA—Reclamation Service has awarded the following contracts for work on Benton Extension. Rowan & Anderson, schedule 1-4 inclusive, (excavation) for $25,200, Oregon Bridge Co., schedules 5, 6, 7 (excavation), and schedule 10 (steel flume), for $21,100, Washington Pipe Co., schedule 8, (wood stave pipe) for $10,600. 1527 acres will be added to drainage district No. 4. Cost of enlargement will be $18,309.53.

OKANOGAN—George H. Keith is preparing plans for courthouse and jail, estimated cost $50,000, also for two-story building for First National Bank.

REPUBLIC—Contract for erection of new school building and remodeling old one has been awarded to Peter Van Lincoln for $27,000. Contract for plumbing and heating to Thompkins & Co. for $3000.

SEATTLE—Council has appropriated $10,000 for extension of lighting in vicinity of Tukwila and Foster.——Contract for paving north half of West Alaska street has been awarded to L. Colluccio at $11,617.12.——P. J. McHugh was low bidder for grading and paving of Stone way at $154,569.10.——V. W. Voorhees, Inc., Eitel Bdg., is preparing plans for additional story on Overland garage building. Estimated cost $20,000.——Contract for plumbing in Ballard high school has been awarded to Petersen Hardware & Plumbing Co. for $29,800.——W. S. Bell and H. O. Shuey, Hoge building, have prepared plans for University Place Christian church. Cost $25,000.——I. T. Gillham, 4550 Latona avenue, has been awarded contract for foundation for Christian church for $10,000.——P. J. Lavan has been awarded contract for heating system of Ballard high school at $33,250. ——Following street improvement has been ordered: grading Admiral way from West Spokane to 63rd; West Spokane from 23rd to Admiral way; 26th avenue from West Iowa to 600 ft. south of south line of West Spokane street; and 59th street southwest from Admiral way to West Stevens street. Improvements will cost about $300,000.——W. H. Milner, Arcade Bdg., is preparing plans for studio buildings for Puget Sound Film Production Co.; cost $250,000.——Contract for alterations and repairs to steamship 'Northwestern' has been awarded to Seattle Construction & Drydock Co. for about $60,000.——Contract for electrification of division of Chicago, Milwaukee & St. Paul railroad from Deer Lodge to Three Forks, Montana, has been awarded to General Electric Company.——Contract for setting poles, stringing wires, and bonding rails on this division, has been awarded to Montana Power Co., Butte, Montana.——Port Commission is preparing plans for extension of West Seattle ferry slip at foot of Marion street. Cost about $25,000.——Bebb & Gould, Denny Bdg., have completed plans for reinforced concrete power house to be built at the Narrows, Lake Washington canal, for U. S. Engineer's Department. Cost $55,000. ——Contracts for sewer work, costing $500,000, will be let in April. W. H. Tiederman, Principal Assistant City Engineer. ——Grand Trunk Pacific Railway Co. will erect frame corrugated iron building, costing $75,000.——Grant, Smith & Co. have been awarded contract for addition to Sears-Roebuck plant. Cost about $850,000.——H. A. Rapp, 307 City Hall, has completed plans for wooden bridge over Duwamish waterway, costing $45,000.——Otis Elevator Co. has been awarded contract for elevators in Central Waterfront cold storage building, for $26,500.

SPOKANE—W. E. Chase Engineering Co. has been awarded contract for ornamental curb lighting system on First avenue. Cost $20,000.——County Commissioners have decided to construct Deer Park and Waverly roads during the coming year. Cost about $150,000.——James N. Smyth Plumbing Co. has been awarded contract for heating, plumbing, and power plant for hotel in Glacier National Park for $80,000.——Oregon-Washington Railway & Navigation Co. will erect buildings for division terminal, costing $100,000.

TACOMA—J. Warter, Sr., has been awarded contract for construction of concrete sidewalks on C street, South 30th and South 35th, at $2795.——W. H. Hicker has been awarded contract for grading and construction of sidewalks on South 66th street, from Union to Mason avenues, for $2782.——Plans are being prepared for water and fire-fighting system in Point Defiance park.——G. L. Gower is secretary of Metropolitan Park board.——Lighting Superintendent Collins has completed plans for luminous arc lights on South D street, Califf avenue, and 11th street.——A 6-in. wood stave water pipe will be laid on N. 24th street.——Pacific Iron & Steel Co. will expend $50,000 for enlarging plant.——Frye-Bruhn Co. will make additions to its building on C street, costing $50,000.——Gerrick & Gerrick, Seattle, have been awarded contract for steel work for Oregon-Washington Railway & Navigation Co. bridge across city waterway at 15th street. Cost $30,000.——Owen Wood, Commissioner of Public Works, will receive bids for construction of storm sewer from South 40th street to M street. Cost $9500.——Weymouth Contracting Co. has been awarded contract for iron frame umbrella sheds at Union depot for Northern Pacific Railway, at $9000.

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Personal

C. F. Bills has been appointed engineer for the Modesto irrigation district.

Warren Charles Perry, architect, has opened an office in the Atlas building, San Francisco.

Edward T. Root and John T. Kerr, architects, have opened offices in the Henry building, Portland.

W. H. McGrath has been appointed manager of the Puget Sound Traction, Light & Power Company.

Haviland & Tibbetts, of San Francisco, have been retained as highway engineers for Santa Barbara county.

Charles P. Weeks, of San Francisco, has been elected president of the Architectural League of the Pacific Coast.

J. Flood Walker, architect, of Santa Ana, has also established an office at 1118 Washington building, Los Angeles.

Dr. Alfred H. Brooks, of the Alaska Bureau of Mineral Resources, has recently returned from a trip to central Alaska.

F. C. Elliott has been appointed president of the White Pass & Yukon Railway, succeeding O. L. Dickeson, resigned.

Charles R. Rockwood has been appointed chief engineer and general manager of the Imperial Valley irrigation district.

Milton Maggini has been appointed city engineer of San Jose, succeeding Irving L. Ryder, who was elected county surveyor.

John J. Sheehan, formerly city engineer of Everett, Wash., has been appointed superintendent of the Mt. Rainier National Park.

Richard Sachse has been appointed chief engineer of the California Railroad Commission, with headquarters in San Francisco.

August G. Headman, of San Francisco, has been elected secretary and treasurer of the Architectural League of the Pacific Coast.

Charles H. Cheney, 2904 Piedmont avenue, Berkeley, is studying tenement and other housing conditions on the Atlantic Coast.

Port Engineer Walsh, of Astoria, has been retained as engineer for the proposed waterway from Seaside, Oregon, to the Columbia river.

Austin B. Fletcher, state highway engineer for California, was elected vice-president of the American Association of State Highway Officials.

The city of Baker, Oregon, has retained J. L. Stannard, of Portland, as consulting engineer for the proposed municipal hydro-electric development.

S. E. Hutton, formerly manager of the works of the Idaho Harvester Co., has been appointed engineer for the Public Utilities Commission of Idaho.

L. M. Rice, chief engineer of the Klickitat Irrigation Co., Seattle is in Washington in connection with legislation affecting the Company's projects.

Ernest E. Walker, landscape architect and civic designer, and Joseph F. Hoss, civil engineer, have opened offices at 1121 Northwestern Bank building, Portland.

Donald B. Roben, Tacoma, has been appointed engineer, and W. G. Brown, Clifton, consulting engineer for the Hylebos Creek diking district near Tacoma.

F. C. Herrmann, chief engineer for the Spring Valley Water Co., San Francisco has resigned and will engage in private practice, specializing in hydraulic problems.

Charles Evan Fowler, M. Am. Soc. C. E., is delivering a course of lectures in connection with the University Extension Division of the University of Washington.

Luther J. Holton has been appointed president of the Oro Electric companies, succeeding W. L. Goodwin. R. L. Van der Naillen has been appointed vice-president and general manager.

A. P. Davis, chief engineer for the United States Reclamation Service, has been appointed director and chief engineer, and former Director F. H. Newell has been appointed consulting engineer.

H. V. Wilkinson, formerly of the Tacoma office of the Westinghouse Electric & Mfg. Co., is now in charge of the industrial and power department of the Seattle district office of the same company.

Jerome Newman, chief engineer of the California State Harbor Commission with headquarters at San Francisco has recently returned from a trip through the Northwest where he made a study of the port improvements at Portland and Seattle.

At the annual meeting of the San Francisco Association of the American Society of Civil Engineers, held at the Palace hotel, December 18, A. M. Hunt was elected president; M. C. Couchot, vice-president; and E. T. Thurston and P. E. Harroun were re-elected secretary and treasurer, respectively. J. D. Galloway read a paper on 'The Construction of the Additional Unit of the Plant of the Great Western Power Company at Las Plumas.'

Obituary

William R. Eckart, Sr., M. Am. Soc. Mech. Eng. died December 8, at his home in Palo Alto, California.

Samuel B. Christy, Dean of the College of Mining of the University of California died November 30, at his home in Berkeley.

Col. Edward D. Meier, past-president of the Am. Soc. Mech. Eng., died December 15 at the home of his daughter, Mrs. Wm. Schevill, 44 West 77th St., New York.

Commercial Paragraphs

The Moreland Motor Truck Co. recently sold two combination hose and chemical trucks to the city of Fresno.

The Pacific States Cast Iron Pipe & Foundry Co. has been organized and will erect a pipe foundry in Portland.

Chas. C. Moore & Co., Engineers, and the Babcock & Wilcox Co. have removed their offices to the Sheldon Bdg., San Francisco.

The Western Reinforced Concrete Pipe Co. has moved its general offices from the Central Bdg. to its new office building and works at Sixth and Utah Sts., Los Angeles.

Allis-Chalmers Mfg. Co. reports the following sales: two 400-hp. variable-speed motors to the Valley Ice Co. of Fresno, one 550-hp. motor and motor-generator to the Pacific Gas & Electric Co. of San Francisco, and two large orders of motors to the American Trona Corporation, San Francisco, and the Golden State Portland Cement Co., Los Angeles.

Catalogues Received

Buckeye Traction Ditchers. The Buckeye Traction Ditcher Co., Findlay, Ohio. Contains a full description of the excavating machinery manufactured by the Company. The regular trench excavators cut trenches up to 12 ft. deep and 54 in. wide, and are fitted with either round or 'apron' or 'caterpillar' traction. The smaller size machines are equipped with gas engines; the larger with either gas or steam. The ditch excavators make ditches up to 12 ft. wide on top and of 6 ft. 6 in. depth, and are equipped with 'apron' traction and gas engines.

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